DOCUMENT RESUME

ED 050 970 SE 011 305

TITLE	Resources for the Future. Annual Report 1970.
INSTITUTION	Resources for the Future, Inc., Washington, D.C.
PUB DATE	Dec 70
NOTE	118p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$6.58
DESCRIPTORS	*Annual Reports, Ecology, Educational Programs, *Environment, Environmental Education, Natural Resources, *Research, *Social Sciences

ABSTRACT

Presented is the Annual Report for Resources For The Future, Inc. (RFF) for the year ending September 30, 1970. This organization is dedicated to advancing the development, conservation, and use of natural resources and the improvement of the quality of the environment through programs of research and education. Most of their studies are in the field of the social sciences. Document content includes an essay by the group's president entitled "Observations on the Environmental Crisis," and two special articles, "Oil: The Middle East and the Western World," and "Social Choices and Environmental Quality" both by RFF members. Educational and research programs conducted in the following areas are described: quality of the environment, water resources, land use and management, energy and minerals, regional and urban studies, appraisals and special projects, and Latin American programs. A list of RFF publications, staff activities and writings, and a financial statement are also reported. (BL)

ED050970

ANNUAL REPORT 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION
& WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

SE 011 305

1

Resources for the Future, Inc. is a nonprofit tax-exempt corporation chartered under the laws of the state of New York, with headquarters in Washington, D.C. It was established in October 1952 with the cooperation of the Ford Foundation. Its purpose is to advance the development, conservation, and use of natural resources and the improvement of the quality of the environment through programs of research and education. Some of its programs are carried out by the resident staff; some are supported by grants to universities and other nonprofit organizations. Most of its studies are in the field of the social sciences.

Library of Congress Catalog Card Number 55-40198

ED050970

RESOURCES FOR THE FUTURE

Annual Report

for the year ending 30 September 1970

1755 Massachusetts Avenue, N.W., Washington, D.C. 20036
DECEMBER 1970

CONTENTS

THE PRESIDENT'S ESSAY

Observations on the Environmental Crisis 3

TWO SPECIAL ARTICLES

Oil: The Middle East and the Western World 15
Social Choices and Environmental Quality 23

THE YEAR'S WORK IN REVIEW

A Summary of the Year 35
Quality of the Environment 40
Water Resources 51
Land Use and Management 55
Energy and Minerals 63
Regional and Urban Studies 71
Appraisals and Special Projects 81
Latin American Program 86
Publications 91
Related Staff Activities and Writings 99

FINANCIAL STATEMENTS 110

BOARD OF DIRECTORS, 30 September 1970

CHAIRMAN, Erwin D. Canham

Robert O. Anderson
Harrison Brown
Edward J. Cleary
Joseph L. Fisher
Luther H. Foster
F. Kenneth Hare
Charles J. Hitch
Charles F. Luce
Frank Pace, Jr.
William S. Paley
Emanuel R. Piore
Stanley H. Ruttenberg
Lauren K. Soth
P. F. Watzek
Gilbert F. White

HONORARY DIRECTORS

Horace M. Albright
Reuben G. Gustavson
Hugh L. Keenleyside
Edward S. Mason
Laurance S. Rockefeller
John W. Vanderwilt

OFFICERS

President, Joseph L. Fisher
Vice President, Michael F. Brewer
Secretary-Treasurer, John E. Herbert

RFF Associates: Lyle T. Alexander, Charles M. Haar, Harvey S. Perloff, John A. Schnittker

STAFF, 30 September 1970

President, Joseph L. Fisher
Vice President, Michael F. Brewer
Secretary-Treasurer, John E. Herbert

QUALITY OF THE ENVIRONMENT

- Allen V. Kneese
- Blair T. Bower
  - Jerome K. Delson*
  - Mason Gaffney*
  - Edwin T. Haefele
  - George O. G. Löf†
  - Thomas H. E. Quimby*
  - Clifford S. Russell
  - Walter O. Spofford, Jr.
- John V. Krutilla (Natural Environments)
  - Charles Cicchetti*

WATER RESOURCES

- Charles W. Howe‡

LAND USE AND MANAGEMENT

- Marion Clawson

ENERGY AND MINERALS

- Sam H. Schurr
- Orris C. Herfindahl
  - Joel Darmstadter

REGIONAL AND URBAN STUDIES

- Lowdon Wingo
  - Edgar S. Dunn, Jr.
  - Irving Hoch

APPRAISALS AND SPECIAL PROJECTS

Hans H. Landsberg (Appraisals)
Francis T. Christy, Jr. (Marine Resources)
Neal Potter†
Ronald G. Ridker (Population)

LATIN AMERICAN PROGRAM

Sterling Brubaker
Pierre R. Crosson
  Ronald Cummings (Mexico)
  Delbert Fitchett (Argentina)
  Michael Nelson (Chile)

PUBLICATIONS

Henry Jarrett
  Vera W. Dodds
  Tadd Fisher
  Nora E. Roots

RESEARCH AND EDITORIAL SERVICES

Elizabeth C. Duenckel
Honor Fairman
Iris L. Long
Sally S. Nishiyama
Pathana Thananart
William J. Vaughan†
Elizabeth K. Vogely†
Cheryl J. Welsh

SECRETARIAL SERVICES

Kathryn B. Albaugh
Maria L. Aveleyra
Jean L. Edes
R. Rita Gromacki
Gail A. McCartney
Doris E. Stell
Diantha W. Stevenson
Helen Marie Streich
Natalie R. Taylor
Vera A. Ullrich

ADMINISTRATIVE SERVICES

Clifford U. Koh
Shirley Deininger
Luis Gonzaga
Ruth F. Johnson

*Temporary staff members with RFF for nine months or more.
†Part-time appointment.
‡Resigned in August 1970.

THE PRESIDENT'S ESSAY

Observations on the Environmental Crisis

by Joseph L. Fisher

Each generation, I suppose, thinks that the problems it confronts are of truly crisis proportions. There is more reason than ever to feel this way today. We in America are beset by a racial crisis, a youth crisis, a war crisis, an urban crisis, a population crisis, an environmental crisis. By crisis I simply mean that a situation has become so bad that something has to be done about it, and done soon.

Each person looks back over the period of his own adult life to find the framework for judging the seriousness of present situations. Three major crises of deep social significance have occurred in this country in my time. First was the Great Depression of the 1930's, at the time altogether baffling in its nature, which severely shook the nation's optimism and self-confidence. The second was World War II. Because the meaning and direction for action were clear, I am inclined to think this crisis was not nearly so soul-searching as that of the depression, however disturbing it may have been to individuals who were called upon to take part in the war effort.

The third great crisis, or set of crises, is upon us now. Manifestations are numerous — youth, minority ethnic groups, the poor, environmentalists, and the rest — but these several separate crises have not yet crystalized to the extent that their combined effect is sharp and clear to me. Perhaps what is involved in each is a recognition of the need for a more effective institutional response to new conditions than has been forthcoming thus far. The poor are uncertain as to whether governments and corporations can mount the programs required to assuage their problems. Minority ethnic groups are finding that laws and court decisions do not in themselves do enough to improve their lot. People everywhere have doubts that they can muster the self-discipline necessary for living in a congested, technological, urban society. The environmental crisis about which I shall speak further raises similar doubts and uncertainties in the minds of everybody. Will the institutions of law and government, of industry and agriculture, of consumers and citizens be able to respond adequately to the forces that threaten our air, water, and land?

In short, will the "system" be able to deal with the crises promptly and constructively; will the "establishment" that runs the numerous public and private organizations of the country succeed in staying on top of the problems? To this question the revolutionaries have their ready answer: tear the structure down, begin again. At the other extreme are an unreconstructed few who are content with things as they are. Most people, however, reject both these courses and would prefer to work with what exists, and reform it.

Of all the crises mentioned earlier I think the environmental one is most susceptible of solution, or at least amelioration. To a large degree it is physical, registered on us through our five senses; also in many instances we already know what to do and how to do it. There is no excuse for not getting on with the job. Perhaps success in reducing pollution will help to restore the confidence needed for handling our other crises.

TWO VIEWS OF THE SITUATION

There are at least two interpretations of this country's current environmental situation. The first is that the environment is in a mess. The air in our metropolitan areas is foul much of the time and occasionally positively dangerous to human health. Our rivers, estuaries, lakes, harbors, and bays are badly polluted, especially those near cities, and most of them are getting worse year by year. The exponential increase in solid wastes — paper, packages, bottles and cans, junk automobiles and other durable products, garbage, mine and agricultural waste materials, and so on — has become a colossal headache for virtually every city council in the country. The mind boggles at the tonnages involved. Insecticides such as DDT and other chlorinated hydrocarbons, now being spread widely through the atmosphere and ocean, constitute a hazard to men and wildlife of unknown but portentous dimensions. The same is true of increases of carbon dioxide in the upper atmosphere caused by the burning of conventional fuels, and also of compounds of mercury and other toxic metals in the water. A call-around of environmental damages would also include radioactive substances, the high level of noise in many places, severe congestion in urban areas, ugliness in both city and country, wretched housing in urban ghettos and rural slums, inappropriate use of wilderness areas — all of which detract from the quality of life to which Americans aspire.

Although accurate and comprehensive statistics on the environmental trends are not available, the evidence nevertheless is clear: the physical environment in most places and in most respects is not improving and is probably going downhill. In the urban air sheds of the country the levels of most pollutants reach higher summertime peaks each year; upward trends of carbon monoxide, hydrocarbons, and oxides of nitrogen have not been arrested, let alone reversed. Organic and inorganic compounds continue to pollute rivers, bays, and lakes on which our cities are located; fish stocks in some of these waters are slowly dying as a result and people are losing valuable recreational assets. Trash is piling up while citizens are reluctant to spend the money required to handle and dispose of it properly.

A few brighter spots are beginning to appear on the horizon, however. The amounts of sulfur dioxide and particulates being discharged into the atmosphere over New York and other cities are dropping. In a few rivers and estuaries, the Ohio and Delaware for example, the long deterioration in water quality seems to have been checked and even reversed in some important respects, though not all. Several states and more recently the federal government have taken steps to ban DDT and similar insecticides in many uses.

What is lacking is a clear picture of the trends and problems in fine enough grain to reveal their subtleties and complexities. Along with others, Resources for the Future is trying to improve the state of knowledge of just what is happening to the environment by developing more accurate indicators of environmental conditions and better ways of determining damage done by pollutants. Clearly the monitoring of various pollutants will have to be extended and improved if the record of what is happening to the environment is to be made more complete. And without a better record on which to base action programs for improving the environment, those programs are not likely to be as effective as they should be.

Granting all of these gloomy portents, there is another interpretation of the present environmental situation that makes things appear considerably more hopeful. In this version present conditions are compared with how things were long ago, perhaps fifty or a hundred years ago. People live longer now; diets are on the whole better; central heating and air conditioning are widely available; people have more leisure time, and at least some use it wisely; hardly anybody dies in this country any more from typhoid and other water-borne diseases; housing on the whole is better than it used to be; and virtually every house is served by electricity. The streets are congested, to be sure, but there is no blinking the fact that most families have the convenience of an automobile. The situation, of course, is mixed and much depends on the viewpoint of the observer, but on the whole, according to this version, life is easier than it used to be.

There are many reasons why so many people believe the environment is worse now, despite many obvious long-term improvements. Some types of pollution on occasion have registered spectacularly on the public—from the foaming faucets of a decade ago to the urban smog alerts of last summer. As we become more conscious of possible links, we begin to look more closely with the aid of greatly improved instruments and techniques, and we come upon instance after instance of new pollution situations we never imagined were present. High incomes for most Americans, plus good diets and housing, have permitted the national attention to turn increasingly to questions of quality.

But two reasons for the rather sudden awareness of the condition of the environment stand out: people now expect a much cleaner environment; they are convinced that the technological means for achieving it are available, that financial resources are adequate, and that managerial know-how is up to the job. As in other aspects of our society, rising expectations, as much as any fine calculation of objective conditions, have given rise to the sense of crisis. This, it seems to me, is altogether healthy; people have a right to expect their leaders to work out the policies and activities through which available technology, finance, and talent can be mobilized to correct bad conditions and satisfy legitimate aspirations.

The other reason why people are distressed about the environment far more than ever before is the brooding sense among us that not only are human health and enjoyment being affected adversely, but the whole ecological support system on which people, animals, plants, and every form of life depend is being undermined. This threat is coming to be perceived in its full seriousness as the ultimate threat.

SOME BASIC CAUSES

As always in a time of crisis, the true nature of the causes is hard to discern. Thus, many who are concerned about the environment believe that population growth is mainly responsible for the mess we are in. Others see technology and economic growth as the culprits. Still others with a slightly masochistic tendency think all of us are to blame as consumers; egged on by advertising in the mass media Americans have given themselves over body, mind, and soul to consuming as much as possible. The country, they say, has been on a long, ever-accelerating spree from which only the most profound changes in attitude and behavior can rescue us.

It is not easy to arrive at an accurate account of the causes of pollution; all of the factors just enumerated are involved. No doubt it would help if population increase could be slowed down; indeed there is good evidence now that if women had the number of children they say they want to have, the fertility rate in this country would quickly drop to that level at which over the long run the population would merely replace itself. (In fact, the fertility rate now is not far above that level in this country.) Of course, the absolute number of people would continue to increase for some decades because of the disproportionately large number of people now entering the childbearing ages and the repercussions of that generation later. In the less developed countries where more than two-thirds of the world's population now lives it is hard to see the end of the tunnel: population is increasing rapidly and will undoubtedly continue to do so for many decades, and the resulting pressure on food and raw materials supplies and on available capital and skilled labor will continue to be severe.

Pollution and environmental deterioration seem to be more closely connected with technology and the production and consumption of goods than with population directly. One of my colleagues, Hans Landsberg, has noted, for example, that 90 percent of the growth in power production in the last thirty years has been caused by higher per capita consumption and only 10 percent by population growth. Or, to take another example, the increase in beef consumption in this country in the past couple of decades would have been only about 35 percent if based on population growth alone; instead, it rose 120 percent because of the increase in the amount of beef each American eats on the average. Underlying these and other per capita increases is the strong desire on the part of consumers to have more goods and services, including the kinds that embody large amounts of land, water, and raw materials. If the villain of the piece is economic growth, then nearly every one of us is playing the part.

The attack upon growth has now been mounted on several fronts; in simplest form it comes out as advocacy of zero population growth and zero economic growth. Should either of these objectives be attained quickly, a host of exceedingly severe problems would result. The age distribution of population would swing rapidly toward a greatly increased proportion of older people, with whatever this implies for prevailing social attitudes; and, with no economic growth, unemployment could become severe. The dangers could be great for any one country that might be successful in its pursuit of zero growth unless other, competing, countries moved in step. Immediate achievement of zero population growth would require that fertility rates drop forthwith well below the long-term replacement rate, while zero economic growth right away would necessitate elimination of further increases in productivity and the material level of living. A no-growth program would be especially hard on poor people. Any finite rate of growth of people or material things ultimately becomes impossible; the real problem is how rapidly to try to move towards rates of growth that can be sustained over as long a period of time as it is useful to look.

With regard to population growth, it seems to me the objective should be to move persistently, not precipitately, to a replacement rate. For the last decade or so the United States has been on the right track and now is not too far from the magic net reproduction rate of one. Improvements in contraception techniques, extension of abortion law reforms already achieved in a few states, more effective family planning services, continued information and education on the nature of population problems — all of these supported by appropriate economic inducements and adequate funding — could well be enough to achieve the replacement rate objective. The need then would be to stabilize the situation at that rate.

The population problem in this country, at least for the next few decades or more, is not so much too many people in all as it is too many people in too few places. Most of the population lives in a relatively few metropolitan areas that occupy a small percentage of the country's land area. The economic advantages of concentration to industry and trade have long been important; more recently the disadvantages of congestion, pollution, and social unrest associated with cities have become apparent. Even if the overall increase in population can be slowed down, the problems connected with its concentration will remain. Unfortunately, little is known for sure about how to alter the pattern of population distribution. Among the possibilities are establishment of new towns out in the country, the channeling of population growth into medium-sized and smaller cities that already exist, and further decentralization within metropolitan areas.

With regard to economic growth, the prescription I would offer is more complicated, but the main outlines are clear. I hope positive efforts, primarily through education, can be made to reduce the emphasis on material growth as a national objective. But mainly I would call for a redirection of economic growth away from activities that pollute or otherwise lower the quality of the environment (the social environment as well as the physical) and toward those activities which prevent or abate pollution or otherwise result in environmental improvement. In short, I am for more sewage treatment works and against more industrial plants that cause heavy pollution, and for more conservation officers and against more purveyors of deleterious products. Generally speaking, such a redirection of economic growth will mean smaller production and consumption of many products and more emphasis on a wide variety of services. Total employment could well remain high and so could money incomes, although a larger proportion of private income would undoubtedly be channeled through governmental expenditures, with services for conserving and protecting the environment displacing to some extent the ordinary run of commercial products. Efforts to shift away from commodities, even in a relative sense, should be discriminating and not take aim at all goods; for example, medical supplies, food, and housing in general should not be held back. Faster progress in redistributing income in favor of poor people would make these efforts more palatable also.

The nation's investment program would also change in the direction of waste treatment plants, pollution abatement devices, waste recycling equipment, urban renewal programs, greatly modified automobile engines or new kinds altogether, and so on. These shifts of emphasis in economic activity will not come about automatically; a variety of policies, regulations, incentives, and the like would be necessary. Just how much investment and consumer expenditures should shift in the environmental direction is hard to say, but one can confidently predict that it will become large if expectations are to be realized.

At the level of general policy it seems to me that the objectives for the economy as set out in the Employment Act of 1946 now need to be changed or at least reinterpreted. This Act states that it shall be the policy of the government to promote "maximum employment, production, and purchasing power." The reinterpretation needs to go in the direction of the language of the National Environmental Policy Act of 1969, one of the purposes of which is "to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man." A qualitative dimension needs to be added to the language of the Employment Act so that the economic advisors would always test their proposals by asking the question, "Employment, production, and purchasing power for what purposes and under what environmental constraints?"

For better or worse the social objectives of government usually are implemented through economic policies and measures. The prevention and abatement of water pollution, for example, will be achieved mainly through public expenditures supported by taxes and borrowing, through tax incentives such as the rapid amortization of particular investments, through charges for the use of publicly owned water courses for waste disposal, and through financial penalties of one sort or another to back up regulations. Regulatory and educational approaches require money if they are to be carried out successfully. Dollars, budgets, and economic incentives are all-pervasive; therefore, it is deeply necessary for qualitative aspects to be placed in the center of economic concern.

WHAT RFF IS DOING

Many of the Resources for the Future studies of resource and environmental problems have taken an economics approach although we have tried to pay close attention to the imperatives and insights offered by ecology, engineering, law, and other disciplines. At the present time, by far the largest of the several RFF programs is one called quality of the environment. A main thrust of this program consists in a systematic examination of how best to manage the waste and residual materials that result from the functioning of the American economy. Special research projects, some done by the RFF staff and some through grants to universities and other research institutions, have been launched in several fields including air pollution, water pollution, solid wastes management, pesticides, and noise. A number of crosscuts are being made: special studies of the major polluting industries, investigations of new technology such as pollution-free automobile engines, studies of pollution in particular geographic areas, and examinations of various policies that have been proposed. Attention also is given to concepts and research methodology by means of which political, economic, and social theory can be reformulated to take account of the widespread and long-term social effects of man's polluting and otherwise disturbing activities. Much attention also is being directed to the possibilities for legal and institutional changes that will be necessary if we in this country are to make decisive improvements in our environment.

In addition to the environmental quality program, several other lines of activity at RFF have a strong bearing on environmental matters. Increasingly our energy and minerals program is directing attention to the environmental as well as the commodity aspects of this subject. During the coming months, a distinguished group of scientists, economists, and administrators will be addressing the complex question of energy, economic growth, and the environment, under RFF auspices. Our land use and management program and our regional and urban program likewise are more and more concerned with environmental quality. Finally one of our newer programs, called natural environments, is addressing the quality issue as it appears in wilderness and back-country places. The objective here is to understand the conditions under which such areas could be used most effectively over an indefinite period of time to achieve social, scientific, and aesthetic, as well as economic, purposes.

Running through all of these environmental quality studies is a common theme: What do we need to know and what changes do we need to make in order to set the policies and manage the natural environment more effectively for the general welfare? Our approaches are broad and systematic; they may not always yield quick results but we have confidence that they will move us forward more surely toward greater understanding of the subject. Without more understanding our responses to crises are not likely to be successful. (A detailed account of what Resources for the Future has been doing recently and what it now has underway is given in the main body of this annual report.)

Much more is needed, of course, than good research. Physiological research on reproduction and demographic research need to be matched with programs of action along lines which the nation can follow with a reasonable degree of confidence. Research on new energy technology in such applications as breeder reactors, gas-fired fuel cells, and nuclear power from fusion needs to be encouraged because of potential advantages of these developments for cleaner air. Progress along such lines would reduce the atmospheric, heat, and landscape pollution associated with the conventional energy industries. The behavior of consumers and producers needs to be changed along many lines if the content of economic growth is to be altered in nonpolluting directions; simultaneously, strenuous efforts will have to be made to confine waste materials close to the sources of origin and to recycle them as completely as possible into useful products.

A tremendous exertion of individual and national will is required to transform the knowledge we already have into programs of action to prevent pollution and improve the environment. Herein lies the real environmental crisis: how to get people and their institutions to do something about the problems. With favorable policies, adequate incentives, and deeper understanding, it should be possible to reduce the environmental crisis to manageable proportions. Only by moving from the somewhat paralyzing awareness of the magnitude and complexity of the general problem to practical programs of action, many of them necessarily at the local level, will the nation be able to turn the crisis to good account and avoid the letdown and frustration that will surely follow if hopes for a cleaner environment go unrealized much longer.

TWO SPECIAL ARTICLES

Oil: The Middle East and the Western World

Among their many implications, recent developments in the Middle East have highlighted the close and precarious relationship of the area's oil-exporting countries with the principal oil-importing countries of Western Europe and Japan. The United States, although not directly involved as a major oil importer from the Middle East, has a large stake in the way events unfold. In one of a series of Middle Eastern studies conducted jointly by The Rand Corporation and Resources for the Future, an RFF group has looked into the outlook for oil from the standpoint of both the producing region and the consuming countries. The article that follows is based on the introductory chapter of a new book by Sam H. Schurr, Paul T. Homan, and others, *Middle Eastern Oil and the Western World: Prospects and Problems.*

Commercial energy drives the wheels of advanced economies throughout the world; for the next decade, at least, the predominant source will continue to be oil. Although the current turmoil in the Middle East has so many aspects that no one of them can be more than a fragment of the whole, it is pertinent to inquire how the situation in that oil-producing region may affect the prospects for world trade in petroleum.

The relationship of the oil-exporting countries of the Middle East to the oil-importing countries of the West is perhaps the outstanding example of international economic interdependence. Both partners benefit from the exchange: importing countries obtain vital supplies of energy at a lower price than from alternative sources, while exporting countries earn sums of money that are vast by almost any standard and are even more impressive when matched against their potential foreign earnings from any other goods and services they might sell abroad.

The terms "Middle East" and "Western World" are used only as a kind of convenient shorthand. Libya and the other oil-producing countries of North Africa have been added to the area generally regarded as the Middle East. With a considerably greater wrench to geography, the "West" includes Japan as well as the heavy consumers of oil in Western Europe.

The ties are strong and likely to become stronger. In 1969 Western Europe imported more than 9 million barrels of oil per day from the Middle East and North Africa, and the projected volume for 1980 is more than 15 million barrels per day. Over the same time period, Japanese imports from these producing regions are projected to increase from about 3 million barrels to over 5 million barrels per day. The share of oil (mainly imports from these regions) in the *total* energy consumption is also expected to increase from about 50 percent in the mid-1960s to over 60 percent in 1980 in Western Europe, and from about 60 percent in the mid-1960s to about 80 percent in 1980 in Japan.

To look at the export picture, about 80 percent of the total oil exports of the Middle East and North Africa are taken by Western Europe and Japan. Oil earnings of Middle Eastern countries and Libya are estimated at about $4.5 billion in 1968, and are projected at close to $10 billion in 1980. In the mid-1960s these earnings accounted for between 70 percent and 90 percent of the total foreign exchange earnings of the five major exporting countries (Iran, Iraq, Kuwait, Saudi Arabia, and Libya), and between 60 percent and 90 percent of their total government revenues.

THE UNITED STATES AS CONSUMER AND SUPPLIER

Neither the United States nor any of the Communist countries alone has a large direct share in the Middle Eastern oil trade. Although the Communist countries, taken together, now account for about 15 percent of total world consumption, they are essentially self-sufficient. In the next decade they are not expected either to draw upon or to compete with Middle East oil supplies to an extent that would impair the current preeminence of the Middle East–Western World trade axis.

The position of the United States is more complicated. This country too is largely self-sufficient in oil, importing only about a fifth of its annual requirements of which, in turn, only a fifth comes from the Middle East — about 3.5 percent of U.S. total consumption. Nevertheless, it is the largest user (as well as producer) of oil among nations, accounting for about a third of world consumption. Although this proportion is expected to drop by 1980 — perhaps to less than a quarter of the world total — the United States would continue to be first among consuming countries. Any change in the level of U.S. imports, whether up or down, would have a strong effect upon world flow of oil.

In addition, the excess producing capacity in the United States has in the past helped to meet supply emergencies in Western Europe and is often thought of as continuing to be a backstop in the future. Equally important is the fact that five of the seven major international oil companies are U.S. corporations. As the main commercial link between the exporting and importing countries, these companies explore, produce, transport, refine, and market most of the oil that moves in international trade.

Uncertainties surround both the future level of U.S. imports and the extent to which excess capacity in this country and the rest of the Western Hemisphere could be drawn upon by Western Europe and Japan in possible emergencies that would curtail supplies from the Middle East. On the latter point, however, it is clear that as consumption levels in importing countries rise, the amounts of oil produced from excess capacity that could be delivered from the United States, Canada, and Venezuela would be a minor fraction of requirements, although they might be very useful in easing temporary shortages in one or two countries.

The future course of U.S. imports is much more difficult to foresee. For a number of years U.S. importation of oil has been subject to a quota system, with the net result that imports have been limited to about 20 percent of total liquid fuel consumption. The future of the U.S supply situation will have an important bearing on the prospects and problems of Middle Eastern oil.

On the one hand, there are the recent rich oil discoveries in northern Alaska with an indicated potential for still larger discoveries both there and in the Canadian Arctic. This could lead to a relative reduction of U.S. dependence on all overseas supplies, including those from the Middle East and North Africa. On the other hand, a relaxation of import restrictions could make the United States a substantially larger market for Middle Eastern oil. During 1969 and 1970 a Cabinet Task Force made a broad reevaluation of current policy, and the majority recommended the replacement of quotas by a tariff system, which would be a more flexible form of control. In August 1970 a decision was taken by the Administration in favor of continuation of the quota system. But over a ten-year span the question cannot be considered closed, especially in view of the relatively low cost at which Middle Eastern oil can be produced. During the next decade, at least, the United States could continue to hold the line on imports from the Middle East and North Africa, if it should choose to do so, and at no greater comparative cost penalty than has been incurred to date.

THE WESTERN WORLD AS CONSUMER

Western Europe and Japan do not enjoy the range of choice open to the United States. If oil consumption in those countries is to increase at a rate consistent with current expectations, they must depend almost entirely upon imports, and the Middle East and North Africa will continue to be by far the most important sources of supply. The only exception would be the possible discovery of vast new oil provinces such, for example, as may be indicated by recent strikes in the North Sea.

At the beginning of 1970, the Middle East and North Africa held proved reserves of about 385 billion barrels out of total world reserves (excluding the United States and the Communist countries) of about 440 billion barrels. No combination of existing export sources elsewhere in the world can begin to satisfy the expected consumption of Western Europe and Japan. There appears to be no doubt that the production of Middle Eastern oil can be expanded at a very low real cost.

How might developments in the new producing regions of the North American Arctic reduce the level of supply dependence of Europe and Japan on the Middle East and North Africa over the next decade? Although much lower amounts are currently indicated, geological inference, informed speculation, and transportation plans appear to support the possibility that Northern Alaska might have "proved-up" oil reserves of as much as 30 billion to 40 billion barrels between 1975 and 1980, which would about equal the present-day proved reserves level of North Africa. If one were to assume comparable success in exploration and development in the Canadian Arctic — a heroic assumption on current evidence — proved reserves in the entire North American Arctic by 1980 might substantially exceed North Africa's current levels but they still would not be in the same league as those of the Middle East. There is even more uncertainty about the rate at which the reserves (whatever they may be) could be translated into daily production capacity. Over the next decade developments in the North American Arctic are unlikely to reduce significantly the dependence of Western Europe and Japan on oil supplies from the Middle East and North Africa. The real importance of developments in the Arctic probably will be that of helping the United States maintain a relatively high degree of independence of these same sources, as it has been able to do in the past.

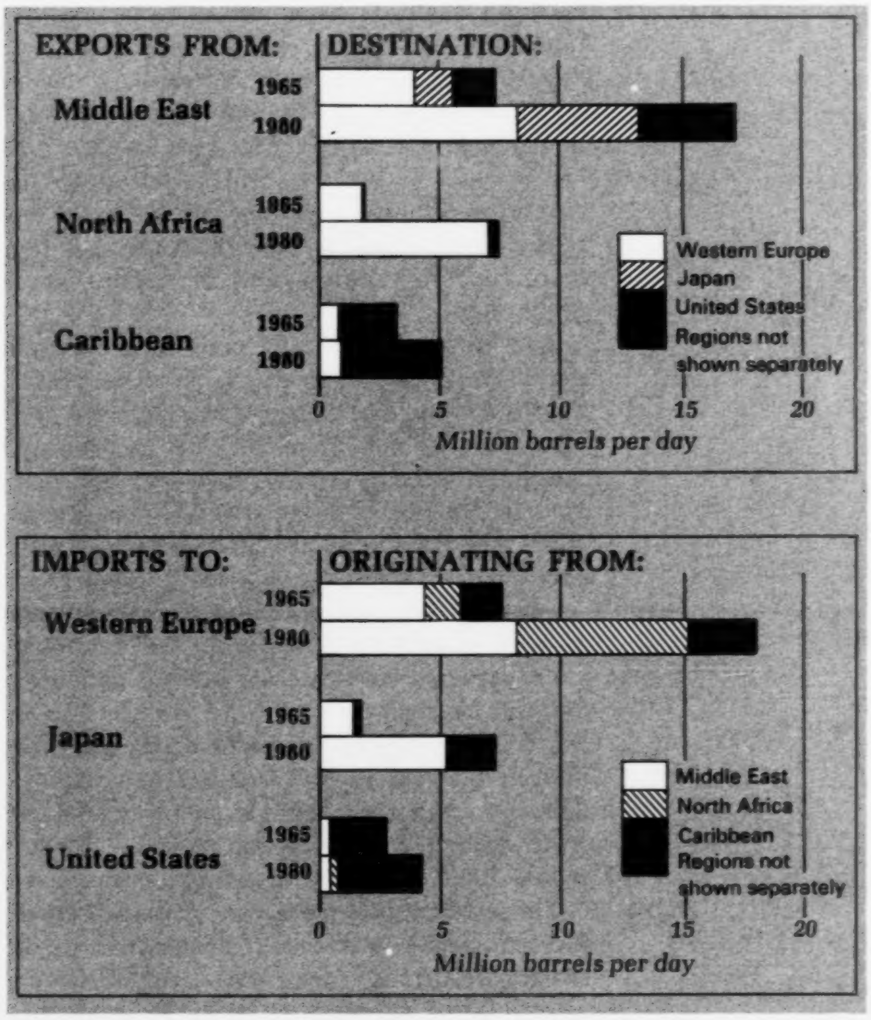
THE MIDDLE EAST AS SUPPLIER

Among the many problems of Middle Eastern oil, two must be noted in even the most cursory consideration of the region vis-à-vis the Western World. One concerns the possibility of interruptions to supply (either resulting from active hostilities in the region, or motivated by other considerations); the other concerns the relationship between foreign-owned companies and the governments of countries in which they operate.

Heavy dependence on oil supplies from the Middle East and North Africa carries with it the obvious danger of interruptions in oil flows. From an economic standpoint this is a serious question for importing and exporting countries alike, because supply interruptions are damaging to both. Their sharp short-run effects are economically painful, and their longer-run consequences also can be damaging if commerce is diverted into other channels that would impose a permanent economic penalty upon those countries that sell oil and those that buy it.

The most recent large-scale interruption of supply was that associated with the Arab-Israeli war of 1967. At that time an essentially new factor came into play: a concerted effort by the Arab countries to turn oil into a political weapon. As the crisis developed, the main producing countries expressed their intention to cut off oil supplies to any Western countries that aided the Israelis in case of war; and President Nasser announced that in such an event the Suez Canal would be closed.

After the outbreak of hostilities the Suez Canal was closed,



According to estimates made for Middle Eastern Oil in the Western World, *by 1980 Western Europe and Japan will be importing more than 20 million barrels per day from the Middle East and North Africa — an amount that would account for about 80 percent of oil exports from the Middle East and North Africa. Oil imports, principally from these two regions, would then be providing over 60 percent of total energy consumption in Western Europe and about 80 percent in Japan.*

and the principal producing countries almost completely stopped oil production and transportation. In addition, an embargo was placed upon shipments to Great Britain, the United States, and in part to West Germany. As things turned out, the halt in production and the partial embargo on oil shipments were relatively brief. No one knows what would have happened if the war had lasted longer.

Continuing tension in the Middle East suggests that the concerted use of oil as a political instrument, attempted once, may be tried again at some future date when it might have a much more severe impact. Other causes also could lead to serious supply interruptions in the future. It is important, therefore, to consider what might be done to reduce the likelihood of such interruptions and to cushion their impact if they should occur.

The most realistic way to keep supply interruptions from being employed as an instrument of policy is to render them useless. If this could be done, the threat to use the embargo of oil shipments as a weapon would be futile, as would its actual use if attempted.

The most practical approach now available is to strengthen the defensive method already in use: the maintenance of emergency stocks of oil in the importing countries of Western Europe and Japan. Under recent policy the targets appear to be about two months of oil imports in Japan and the European Economic Community. Stocks in Great Britain were reported at a four months' supply in 1966, and are said to have declined since then. Emergency reserves of this size are inadequate.

An economic approach to estimating prudent stock levels begins with an examination of the foreign exchange reserves of the Arab oil-exporting countries. For periods ranging from one and one half months for Iraq to thirty-one months for Kuwait, those countries could have forgone earnings from oil sales and still have been able in the mid-1960s to cover their current ordinary imports by drawing upon their cumulated foreign exchange reserves. Libya's and Saudi Arabia's staying ability, calculated on the same basis, would have been five and eight months, respectively.

These calculations are conservative because they do not include foreign assets statutorily designated as required for currency cover. Neither do they distinguish between essential and nonessential imports. In a crunch, the staying power of the exporting countries would be substantially greater, the more so because most of their populations are rural and largely self-sufficient. Against all this must be put the fact that many leaders in the producing countries are aware of the long-run importance of oil industry operations as the foundation upon which the economic development of their countries must be built.

Clearly it would be prudent to build up stockpiles well beyond the present official targets. Stock levels equal to oil imports for six months or even longer are recommended as a reasonable planning target for the countries of Western Europe and for Japan. Such stocks would require a heavy investment in both oil and storage facilities — in Western Europe the costs of a six-month reserve against 1975 needs might exceed $7 billion in prices of the late 1960s. Even so, the "insurance premium," or surcharge per barrel of oil consumption, would not result in a high price for Middle Eastern and North African oil when compared with other energy sources.

PRODUCING COUNTRIES AND THE MARKET

During recent years oil-producing countries have engaged in two persistent drives: one is to increase the revenues received from concessionaire companies; the other is to assume greater control over the exploitation of their oil resources, largely through national companies and participation in joint ventures with foreign companies.

Beginning in the 1950s, one country after another achieved an arrangement for profit-sharing with the concessionaire companies instead of continuing earlier arrangements that provided for relatively low royalty payments. Under the new arrangement — the so-called 50-50 formula — the countries obtained 50 percent of net profits, calculated on the basis of the posted price of oil, and thereby greatly increased their revenues.

As oil product prices declined in world markets in the late 1950s, companies began to lower the posted price of crude oil, thereby reducing the tax revenues of governments. Governments resisted, and succeeded in preventing further declines of posted prices. The latter consequently lost their relationship to market prices and became simply a nominal base for calculating tax liabilities of the companies. Given this base, taxes have become in effect a fixed charge. This inescapable cost to the companies has been averaging 80 to 90 cents a barrel in the Middle East.

As the producing countries attempt to expand their market role through their own national companies or other forms of participation in ownership of production facilities and in the sale of oil, their problem is how to do so without disrupting the international price structure on which their oil revenues depend.

The root of the problem is that large reserves of oil are producible at low real costs. Estimates of real costs in the Middle East and North Africa run from 10 to 20 cents a barrel. When government taxes of around 85 cents a barrel are added as a cost that the concessionaires must meet, a figure of $1.00 or more per barrel defines the limit to which prices might be driven by competition. Prices are still well above this cost base, but they have declined considerably in the past decade and appear likely to continue downward over the long run. Under such circumstances the per-barrel tax stands as a barrier to a deep competitive erosion of prices.

However, when producer-country national companies attempt direct entry into the international market, even on a relatively small scale, they expose themselves to the danger of further eroding the price structure. If, at the same time, the countries attempt to increase their tax take from the foreign-owned oil companies, some concessionaires may be ground between higher taxes and lower prices to the point where they can no longer obtain an acceptable rate of return on development investment. They might then be forced to withdraw from their concessionaire status and simply become contractors or purchasers and transporters of oil produced. If national companies were then to take over a major portion of oil production, they would have to look to the international companies as purchasers of their oil. Only these have the necessary marketing and transportation network; consequently they would be in a position to strike hard bargains. With countries competing in the sale of oil, prices could be driven downward, with no bottom limit except the low real cost of oil production.

Some observers think that this is the likely course of events. Others consider that those now in positions of responsibility in producing countries have a sense of economic realities and that companies have an adaptability to changing circumstances sufficient to avoid a breakdown in company-country relations.

If the producing countries were able to cooperate in a strong cartel and to develop the capability to market and transport oil, they would be in a better position to bargain with the companies or could even end the major concessions without disastrous consequences to themselves. However, without an effective and durable cartel it is hard to see how producing countries could dispense with the functions now performed by the international companies without serious costs to themselves.

The present facts of international oil can be made to support widely varying inferences about the future. One line of analysis suggests that unleashed competition abetted by unruly political forces will eventually erode the economic benefits currently reaped by the producing countries and disrupt the existing structure of relations of countries and companies. On the other hand, it is possible to imagine various sorts of negotiated solutions that, while bending somewhat to economic and political winds, may retain much of the substance of present arrangements. Informed observers appear to agree that abrupt termination of existing relationships is unlikely if the countries are motivated by concern for the economic consequences of their actions. However, it is well to keep in mind that in the Middle East economic considerations may not turn out to be the decisive factors.

Social Choices and Environmental Quality

The present market mechanism is of little use in deciding questions of environmental quality; individual shares of clean air, clean water, and other such amenities carry no price tags. Social choices are called for, usually through the political process. Here, the need for new or improved institutions is often noted, but is seldom explored so systematically as it has been over the past three years by Edwin T. Haefele, of the RFF research staff. The article that follows is based on a paper presented by Mr. Haefele last June at an RFF conference on Environmental Quality and the Social Sciences. [See page 40.]

Although there is little reason to think that he had the twentieth century on his mind, Aristotle stated the nub of the modern problem of environmental quality more than 2,000 years ago: "For that which is common to the greatest number has the least care bestowed upon it." Since we have not been able to assign private property rights to all the air and water, we have owned them in common and cared for them least. Now that we have overused them individually, we face the task of bringing these common property resources into some system of governance. We shall in the future have to make collective — that is, social — choices, rather than individual choices, about their uses.

Making social choices brings some special problems. It is often a case of "either-or." When such questions concern goods or services obtainable through the market, each individual can choose what and how much he will buy. When "either-or" choices involve a number of people, some of them are not going to get what they would like. That fact has been one of the main reasons for governments throughout human history. Dictatorial states approach this problem differently from states that try to determine social choices from individual preferences.

Other attributes of social choices are also bothersome. Besides being either-or, they are apt to involve conflicting or multiple objectives, with no generally accepted criterion for sorting them out. In many social choices the capricious relationship of who benefits and who pays creates a further set of problems. There are public goods and services, like air pollution control or flood protection, that, if provided, are available to all. Some people may be paying less than their share while others may be paying for something they do not want. Then, some common property resources — a river system, for example — serve multiple purposes. Although it is possible to charge users of the water, be they industries, municipalities, fishermen, or boaters, it is not altogether clear what each user should be charged. Because any true joint cost is just what it implies, precise allocation on cost principles is impossible.

Individual choices registered through the mechanism of the free market obviously cannot be depended upon to provide tolerable resolution of current problems of environmental quality. Neither will political resolution at the traditional local, state, and national levels of government in the United States suffice, because areas of political jurisdiction do not often coincide with the areas that share a common problem. Deciding these important questions in present jurisdictions may well leave the majority of citizens dissatisfied: much would depend on who selects and frames the isues to be voted on.

Yet it is equally clear that solutions must be found within the accepted framework of representative government and a predominantly two-party system.

As it relates to social choices on questions of environmental quality, particularly air and water quality, the present governmental structure offers few of the advantages of representative government, or of the party system. Most of the choices made consciously by governments are made either by technicians who try to "balance" the interests of the affected parties or by a small group of politicians who hide their choices behind a "technical" but meaningless benefit-cost analysis. We thus have the worst of both worlds — technical analysis debased by political judgments, and political deals in which only a small number and perhaps the wrong people may play.

In the past, executive agencies may have been able to handle such problems by using the device of the public hearing and citizen or special-interest advisory committees. Now the need is for truly representative governments, using the advice of technical and administrative advisory committees, but arriving at decisions by legislative process. When real social choices are at stake, nothing less than representative governments can make them. The spectacle of executive personnel attempting to assess the public interest through public hearings or to devise appropriate actions through committees appointed "representing" all interests from housewives to steel mills does violence to our system of government. It does not aggregate individual preferences correctly into social choices.

THE MECHANICS OF GROUP CHOICES

Americans were extraordinarily successful at constructing social choice mechanisms in the seventeenth and eighteenth centuries, when the colonists used representative legislative bodies to wrest policy control from Crown-appointed governors and executive councils. Later, their skill in this area seemed almost to die out. Instead, they perfected managerial and executive skills in both business and government. Faced now with value conflicts that call for social choices, they grope to relearn some of the older arts. In the meantime, social scientists have developed some useful approaches. We in the United States may be farther along than is generally recognized toward a basis for constructing new mechanisms for making social choices. In recent years research by economists and other social scientists has thrown new light on some of the ways collective decisions are arrived at.

One of these advances concerns the mechanics of group voting. In any legislature, commission, or committee composed of a number of independent members, some coalitions or blocs have always been known to be more powerful than their numbers would indicate. The variation between the relative numbers and the real voting power, which in the past was sensed only vaguely, now can be measured with some precision by means of techniques developed by L. S. Shapley in the 1950s.

The Shapley value calculates how many times each voter or bloc can appear in the "pivot" position by providing the winning margin for one side. To give an example, assume an eleven-member group in which there are two voting blocs of three members each, one two-vote bloc, and three voters who belong to no bloc. Assume also that a simple majority of six votes is needed to win on any issue. By proportion, the relative power of a three-vote bloc (3/11) would be about 27 percent, and that of a two-vote bloc and a single vote, 18 percent and 9 percent, respectively, when all possible combinations are considered equally likely. Instead, the relative strengths are more nearly 30, 20 and 7 percent. The difference, though not great, is significant, and there can be extreme cases in which some voters have no power because they can never be in a pivot position. Requiring more than a bare majority for a decision also can have great effect on relative voting power, as the discussion of the proposed Potomac River Basin compact later in this article will show.

The Shapley value is particularly useful in analyzing new institutions because of the "all permutations equally likely" assumption. In more localized situations this assumption can be modified to reflect experience of different probabilities for forming coalitions. On the whole, the smaller voting groups can make their influence felt by trading votes. This practice results from the variations of intensity with which voters or voting blocs regard each issue. If, for example, one voter is strongly against one proposal and mildly in favor of a second, an exchange can be arranged with a voter whose feelings are just the opposite. The more voters and the more issues there are, the more useful vote trading is in reaching valid social choices. A further assumption should be noted here: that the basis of representation of any decision-making body is territorial rather than functional. In a body whose members represent classes or interests, rather than all the residents of a certain geographical area, the results of vote trading are likely to be a mere division of the spoils.

Recent research has developed useful information on the probable patterns of vote trading. Similar statistical analysis has yielded results on the effects of changing the size of the majority required to approve a proposal.

In our example thus far we have been talking in terms of a group — whether a commission, a legislative committee, or whatever — that makes social choices in a certain field. How the individuals became members of such a group is even more important. A two-party system, through selecting and defining issues and establishing an order of priority among them, has the unique characteristic of being able to represent all of the electorate. The process is similar to the vote trading and ordering of preferences that has just been discussed. That is, the two-party system *can* (that is not to say it always, or now usually, does) throw up those two positions which, when voted upon, result in the same choice as would have been made if *all* voters were assembled and capable of exploiting vote-trading possibilities.

A functioning party structure is the means by which issues can be defined and stated in a responsible manner. No other group or organization in society has this task. The press has no warrant to do more than raise cries of alarm and argue points of view. Special-interest groupings have no interest beyond their own. Neither has any responsibility for decisions and cannot be made responsible. The executive branch of government cannot be counted on to formulate issues appropriately because it is controlled by one party at a time. While all of these groups and many others contribute to the formulation of issues, only the party system, which runs candidates and is identified as responsible for programs once elected, is qualified to define the area of battle.

The two-party system in twentieth century America has played less than its appropriate role in issue formation, even though the utility theory of representative government depends upon a two-party system that is able to formulate the issues appropriately. American government depends much more on parties than we suppose. We neglect parties at the peril of having to contend increasingly with intransigent, nonnegotiable demands made by one or another faction within our society. A government can "cope" with demands, but such actions should not be confused with the process of self-government under any definition.

THE PROPOSED POTOMAC COMPACT

The proposed Potomac River Basin compact offers a concrete example of the problems and possibilities of significant improvements in arriving at true social choices on environmental issues within the existing institutional framework.

Governmental jurisdictions at local, state, and federal levels are now in the process of designing an institution to make environmental choices regarding the uses of Potomac water. The proposed federal-interstate compact would establish a river basin commission, composed of the governors (or their representatives) of West Virginia, Virginia, Pennsylvania, and Maryland as well as appointed representatives for the federal government and the District of Columbia.

The case for coordinated or unified management of the river is compelling. Were efficiency gains the only issue, river basins could well be turned over to any efficient organizational form — a public corporation, a franchised monopoly, or a cooperative.

But there are other important aspects of river basin policy, which are not necessarily consonant with economic efficiency considerations.

The four major objectives for river basin investment are:

economic efficiency — where the criterion is to put investment where the aggregate pay-off is greatest in economic terms or where the aggregate economic cost is least if the objective function is externally imposed;
equity — redressing the balance on the incidence of benefits and costs on programs taken in pursuit of economic efficiency;
income distribution — where the criterion is some specified redistribution of income through programs having a differential impact on costs and benefits;
reallocation of resources — where resources are deliberately forced into noneconomic patterns for a specific public policy purpose.

Only the first of the four is a management issue, the other three are questions where conflicts in values will certainly occur. Consequently the interstate compact, in its present form, is suspect as a political mechanism for making social choices.

Some 4 million people live in the Potomac River Basin. Disregarding, for a moment, the 760,000 District of Columbia residents who have no political representation anywhere, the other basin residents do not dominate any state government of the area.

The basin residents do not nominally control either house of any of the legislatures. When one adds the fact that the voters of each state who live in the basin are by no means unanimous on what they want in terms of water choices for the Potomac, and thus will not function as a bloc, it is obvious that the state legislatures do not have a clear claim as the appropriate bodies to resolve the issues. The distribution, by area as well as population, follows:

State	*% of State Area in Basin*	*% of State Population in Basin*	*Population in Basin*
Maryland	36	27	1,339,000
Pennsylvania	4	2	185,000
Virginia	14	23	1,103,000
West Virginia	15	8	148,000

Even less appropriate is the provision of the proposed compact that would give each state one vote, along with one vote each for the District of Columbia and the federal representative. The distribution of the basin population shows a far different proportionality: District of Columbia, 22.6 percent; Maryland, 37.4 percent; Pennsylvania, 5.2 percent; Virginia, 30.7 percent; West Virginia, 4.1 percent.

Even though the interstate compact in its usual form is not appropriate to the Potomac Basin, it is necessary, of course, that state power be brought into the picture. The compact could be made to safeguard the interests of basin residents through a requirement that the states delegate power to basin residents, who then would elect the members of the commission. They would vote on the basis of equal population districts (congressional districts furnish a suitable, ready-made structure closely coinciding with basin boundaries). In addition to the one federally appointed member, representation on the commission would then be on the basis of about 400,000 people per vote for the other ten members. Maryland (Cong. Dist. 5, 6, and 8) and Virginia (Cong. Dist. 7, 8, and 10) would have three votes each; Pennsylvania (Cong. Dist. 12) and West Virginia (Cong. Dist. 2), one each; and the District of Columbia, two votes.

If we assume the existence of such an elected commission, then we can make some judgments about the decision rules under which the commission might operate. First, using Shapley values, we can test the bloc power by states, assuming that jurisdictions with more than one vote would always vote *en bloc*. From the changes in voting power shown in the top table opposite, it can be seen that increasing the majority required for approving decisions strengthens the one-bloc votes, but more at the expense of the District of Columbia's voting power than of that of the three-vote blocs.

It is perhaps more realistic to explore some possible upstream-downstream cleavages, again using Shapley values. The lower table makes three separate assumptions about how the upstream-downstream coalitions would shape up, and then tests the voting power under each. Here the voting power values fluctuate sharply;

Nominal Voting Power, by State,
Under Different Decision Rules

Area	Number of votes	RELATIVE VOTING POWER OF EACH BLOC IN PERCENT: Votes needed to pass = 6	Votes needed to pass = 7	Votes needed to pass = 8
Maryland	3	30.00	28.33	28.33
Virginia	3	30.00	28.33	28.33
District of Columbia	2	20.00	18.33	13.33
Pennsylvania	1	6.66	8.33	10.00
West Virginia	1	6.66	8.33	10.00
Federal Representative	1	6.66	8.33	10.00
Total voting power	**11**	**100.00**	**100.00**	**100.00**

some changes in the decision rules making dramatic shifts in relative power and others having no effect at all.

There is no legal reason why the states could not negotiate a compact that would include such a representative pattern, nor is there any legal reason barring the Congress from approving it. Were this to be done, the compact would undoubtedly also provide that any state funding would come from assessment of basin

Upstream-Downstream Voting Power
Under Different Decision Rules

Number and size of blocs		RELATIVE VOTING POWER OF EACH BLOC IN PERCENT: Votes needed to pass = 6	Votes needed to pass = 7	Votes needed to pass = 8
CASE I	1 five-vote bloc	50.00	58.33	50.00
	1 four-vote bloc	16.67	25.00	50.00
	2 one-vote blocs	16.67	8.33	0.00
CASE II	2 five-vote blocs	33.00	50.00	50.00
	1 one-vote bloc	33.00	0.00	0.00
CASE III	2 four-vote blocs	30.00	35.00	50.00
	3 three-vote blocs	13.00	10.00	0.00

residents only, rather than from general state revenues. Such a provision would not only be essential for equity but fundamental to fiscal responsibility. It is a well-known defect in federal grant-in-aid programs that the money is usually available only for certain specified technical remedies, thereby reducing the incentives of the state and localities to use any other remedies even though they might be more efficient. Likewise, if basin residents receive funds from their state's general revenues, their choices will be biased in the direction of those features funded by the state.

An interstate compact which sets up a representative basin commission will not, of course, solve problems created by grants-in-aid tied to particular solutions. Also, a basin-based commission could create some administrative problems within each state. Answers to such questions lie in the interstate compact itself. If a representative basin commission were established, it would have to have a clear delegation of state authority regarding water policy and a sharing of state authority in the recreation area. The administrative problems that would arise are minor compared with the larger problem created by the present interstate compact proposal which ignores real basin representation.

Attempts to provide for basin representation by advisory committees dealing with recreation, land-use planning, and other special interests do not serve as surrogates for representative government in weighing values. Any citizen has many interests. He may be an avid fisherman *and* a pinch-penny taxpayer. He may be a land speculator *and* a supporter of free recreation. If citizens are represented only by their special interest groupings, the resulting pressures do not necessarily converge toward any real public choice. It is when each citizen must resolve, within his own mind, how he feels about all aspects of the river basin that choices begin to converge, extreme positions fall, and public choice becomes realistic. But the citizen, speaking as a whole man, can do so only if he can vote. Since he cannot vote on all the technical issues, he should vote on his choice for a representative. If representatives are to throw up the correct choices for him, then the two political parties should be sponsoring the candidates.

If a basin commission is given broad authority to act, the many citizen interests that are now frustrated in the "public hearing" charade can make very live election issues out of the real alternatives and the candidates offering themselves for election.

SOME CONCLUSIONS

By viewing environmental quality as a social choice problem and representative government as a mechanism that has unique capabilities for aggregating individual preferences into social choices, we are able to reach some general conclusions about the present state of institutions in the environmental field. They may be summarized as follows:

There is a need to redress the balance between the legislative and the executive role in environmental choices at all levels of government. The supremacy of the legislature for policy determination, firmly established by the early eighteenth century, has been gradually eroding for more than two hundred years. We now face, again, the need for a strong modern legislature, because the executive branch cannot make broadly based social choices.

There is a need to force environmental issues into partisan politics at every level of government. If the representative system is to bring out the appropriate set of issues "correctly" formulated for social choices, it must have a two-party system working to gain adherents. We have had massive misunderstandings of the functions of parties. They are essential to the process of aggregating individual preferences into social choices.

Environmental issues, while they have local, state, and federal aspects, are often primarily regional in nature. Sometimes the region is in one state, sometimes in more than one. There is therefore a need for representative governmental structures at the regional level. These may either be created by one state, or by several by means of compacts. In either case, both the legislative and the executive dimensions must be attended to.

The federal role would emphasize, on the legislative side, the questions of how much money to appropriate for environmental purposes and what regional distribution to make. On the executive side, the federal government has many kinds of technical expertise (in particular that of the Corps of Engineers) which it could make available on request to regions and states on an at-cost basis.

The states, regions, and localities would, on the other hand, be making environmental choices, designing and carrying out programs to implement the choices, deciding how to allocate federally disbursed monies, and determining what additional funds were needed from local sources.

The picture would then be far different from the current one, and far closer to the process of self-government envisioned for the country two centuries ago.

THE YEAR'S WORK IN REVIEW

A Summary of the Year

Work on problems of environmental quality was intensified and broadened during the 1970 program year. Much of this research was interdisciplinary, involving the natural sciences and engineering as well as the social sciences. Because environmental aspects are often so closely interwoven with the more traditional considerations of natural resources supply and demand, the distinctions between RFF's original main areas of inquiry have become less pronounced; the large environmental problems nearly always are rooted in the way we use land and water, energy and minerals, and the processes of regional or urban growth. Continuing a trend that was noted last year, increased attention was given to situations beyond the borders of the United States, both in their own right and for their domestic implications. More projects than in the past were carried out in cooperation with other nonprofit organizations.

■ All aspects of RFF's research into environmental quality by both staff members and grantees were brought together at a conference held last June. The papers, summarizing work done up to that point, dealt with three major types of problems: prospects of economic growth in the face of finite natural resources; methodologies for programs of residuals management; and the design of political and legal institutions for managing common property resources. At the close of the year the papers were being revised for future publication.

Two studies were completed and were in press at the close of the year: a set of detailed regional projections of water supply and demand in the United States through the year 2020, with special attention to the demand for water quality as well as quantity; and a monograph on the applicability of a materials and energy balance approach to problems of resource allocation.

In the search for ways to reduce air pollution, a study of alternatives to the internal combustion engine in propelling vehicles was completed and at the close of the year the manuscript was being edited.

Work begun included a study of noise management, a broad inquiry into the industrial recycling of materials, and two detailed studies of waste recycling in the wool reprocessing and paper industries. Extending RFF's work on the relation of governmental processes to environmental problems, a new study was begun of the structure and decision-making machinery of local governments.

Several studies concerned the value of natural environments as assets in themselves rather than as resources to be exploited by mining, logging, and other extractive industries. A general study explored the hypothesis that advances in technology may be reducing the pressure on wild land and water resources as sources of raw materials at the same time that demand for their preservation as natural areas is increasing. Other work completed during the year included an economic analysis of alternative uses of Hells Canyon and a systematic effort to classify and evaluate scenic resources. In press at the end of the year was a monograph on competition for the use of wetlands in the prairie pothole regions. [See Quality of the Environment section.]

Toward the close of the year arrangements were made for a program of studies of the impact of population size, growth, and distribution upon environmental quality. [See page 84.]

■ The two manuscripts that RFF is contributing to a series of Middle Eastern studies conducted jointly with The Rand Corporation were in press at the end of the program year. One deals with the situation and prospects for oil, and the other with those for agriculture. [See pages 66 and 55.]

At the request of the International Bank for Reconstruction and Development, an RFF staff group reviewed the many planning and survey studies that have been made for the Lower Mekong Basin in Southeast Asia, and presented their findings on the possibilities for agricultural and power development in that part of Southeast Asia. [See page 57.]

In a joint research effort with the Bank, RFF is seeking to relate recent results of research into the process of urbanization to the special circumstances of developing countries. [See page 79.]

As part of RFF's continuing program of cooperation with the Latin American Institute for Economic and Social Planning, the Institute published a condensed Spanish translation of a book that had been jointly sponsored by the two organizations and had translated another, which is being prepared for publication. Under the same auspices, the draft of a study of tropical colonization efforts in Latin America has been completed.

In the teaching and research program begun last year in Mexico and Argentina, RFF representatives lectured, worked with students, and helped direct research at institutions within the two countries.

A detailed study of natural resources in Latin American economic development was published, and a case study of agricultural productivity, based on the experience of Chile, was sent to press. [See Latin America section.]

- In the field of water management, a study of methods of evaluating actual performance of projects as compared with cost/benefit calculations made in advance was completed during the year. An analysis of fiscal policy and resource allocation, of special importance to water development, but with general application to the theory of public finance, was published. Also published was a study of transfers of water between different uses. A study of interbasin transfers of water and a case study of the effects of drought upon urban water supply in Massachusetts were sent to press.

  An inquiry into the possible impacts of technological advance upon demand for water, undertaken for the National Water Commission, was completed. Also finished was an economic-hydrologic study of the management of ground water in conjunction with surface supplies. [See Water Resources section.]

- Work was begun on an economic analysis of the temporal allocation of natural resources, in which special attention is given to efficient investment in range and soil conservation. A broad study of resource allocation and use in American agriculture was completed, and a manuscript was under review at the close of the year. A small working conference held in June considered the special problems of the nation's rural areas; a monograph is being prepared on the basis of the findings. A study of suburban expansion and rural land conversion in the United States was sent to press late in the year. [See Land Use and Management section.]

- Research into the regulation of natural gas, begun last year at the request of the Office of Science and Technology in the Executive Office of the President, resulted in the preparation of ten background papers for presentation at a seminar held in October 1970, just after the close of the program year. An economic analysis of petroleum conservation in the United States was sent to press.

  Two studies of international aspects of energy and minerals were sent to press: one deals with relations between host countries and foreign companies that produce petroleum or minerals, and the other with changes since 1950 in the location of steel production and in world supply and demand for iron ore. A comprehensive analysis of energy in the world economy, tracing changes in supplies, consumption, and international trade between 1925 and the mid-1960s was being edited. Late in the year research was begun into the structure of the world copper industry and the implications of increased government control or outright nationalization for the future volume and distribution of the world supply.

Three studies begun during the year relate to the adequacy of mineral resource supplies. Two of them look toward statistical approaches to improve the efficiency of minerals exploration, while the third canvasses the possibilities of using substitutes to ease pressure on resources for which the supply situation is tight. [See Minerals and Energy section.]

- A primarily economic analysis of the use and allocation of the radio spectrum, a common-property resource, was completed and sent to press.

  A study of regulatory systems for international fisheries was begun. The investigation will review and evaluate existing commissions and agreements and suggest possible improvements. [See Appraisals and Special Projects.]

- Research on regional and urban problems focussed on impacts of explosive urban growth in the United States and abroad. In a manuscript sent to press during the year, a concept of social learning is advanced as a more useful framework than conventional economic growth models for analyzing and interpreting regional and urban change.

  Four new studies of regional and urban growth patterns were begun: one seeking a new general concept of the urban system, and three dealing in different ways with determinants of the size of cities or regions. An inquiry into the structure of the urban economy, with emphasis on changes in patterns of population density, was completed and in manuscript form at the end of the year.

  In an exploratory effort, a group of scholars and public administrators was convened to survey current practices of metropolitan governance and to suggest improvements.

  A monograph that examines federal policy for economically distressed areas was completed and sent to press. [See Regional and Urban Studies section.]

- The 1970 year was the beginning of the fourth five-year period during which RFF's work has been supported by grants from the Ford Foundation. Two additional grants were received during the year. The Rockefeller Foundation provided $500,000 to support additional research on environmental quality during a three-year period beginning 1 January 1970. A supplementary grant from the Ford Foundation became available 1 September 1970, to support continuation of RFF's doctoral dissertation fellowship program over a three-year period. As noted above, RFF undertook two smaller research projects under government contract; both were in line with RFF program objectives.

  Twelve fellowships amounting to $46,800 were awarded under RFF's competitive program for doctoral candidates whose dissertations will deal with social science aspects of natural resource problems. Five RFF fellows of previous years presented dissertations to their universities (page 84).

Twenty-three grants, amounting to over $355,800, were made during the year.

Five books were published and fifteen were sent to press, six of which are scheduled for publication by the end of December and nine for publication in 1971. [See page 91.]

BOARD OF DIRECTORS. At the October 1969 meeting of the Board of Directors, William S. Paley resigned as chairman and Erwin D. Canham was elected as chairman in his place. Mr. Paley continues as a member of the Board, on which he has served since 1953. Edward S. Mason, who has served on the Board since 1964, retired during the year and became an honorary director. Leslie A. Miller, an active member of the Board from 1953 to 1965 and an honorary member since then, died in September.

STAFF. Two staff appointments were made. Ronald G. Ridker, who came to RFF in September, will concentrate on population growth as it relates to the natural environment and economic development. He has recently served with the Agency for International Development as chief of the Planning Division for the Near East South Asia Bureau, and earlier as economic adviser to AID's Mission to India. Thomas H. E. Quimby began a one-year appointment in August to work with the quality of the environment program in its studies of waste recycling industries.

In August, Charles W. Howe resigned as director of the water resources program to join the faculty of the University of Colorado as professor of economics. Three visiting scholars returned to university work after completing appointments with RFF: A. Myrick Freeman III, rejoined the faculty of the department of economics at Bowdoin College; Robert H. Haveman joined the faculty of the department of economics at the University of Wisconsin; and Robert A. Young joined the faculty of the department of economics at Colorado State University, Fort Collins.

Joseph L. Sax, a Ford Foundation visiting scholar who worked with the RFF staff for most of the year, rejoined the faculty of the University of Michigan, where he is professor of law.

Quality of the Environment

Public involvement with issues related to the quality of the environment increased during 1970. Communities, business, industry, labor, students, the professions, and government alike have become actively concerned. More and more, environmental problems are coming to be recognized as largely a consequence of the market's failure to provide incentives for efficient use, development, and conservation of common property resources, and of governmental lags in finding remedies through collective actions. The "common property resources" are those natural assets that are difficult or impossible to reduce to private ownership. They include the air mantle, watercourses, complex ecological systems, and various aspects of space including landscape and the electromagnetic spectrum. Today there is strong interest in analyzing mechanisms of collective choice and decision making with respect to these resources, and the building of analytical tools for regional management of common property resources has made encouraging progress. Particularly in connection with this effort, the points of intersection among social science, natural science, and engineering are becoming clear. We are even starting to learn something about size and distribution of the social costs which deterioration of our environmental resources is imposing on the public.

Issues like these were the focus of a research conference held by Resources for the Future during the summer. Reports based on RFF current and continuing research on environmental quality matters were prepared for the conference and are now undergoing revision for future publication.

The conference papers cover the following three main subjects:

the problem of economic growth in the face of finite natural resources (including common property resources);
methodologies for developing programs concerned with residuals management; and
design of political and legal institutions for the management of common property resources.

Because these subjects also reflect the main divisions of RFF research in environmental quality, they provide the structure for discussing both the conference papers and other work done during the year.

ECONOMIC GROWTH AND FINITE NATURAL RESOURCES

A conference paper by Ralph d'Arge was based on work RFF is supporting at the University of California, Riverside. D'Arge applies the concepts of economic growth theory to situations where finite limits exist: to nonrenewable natural resources that serve inputs to the production-consumption process, and to common property environmental resources whose ability to accommodate unrecycled material residuals from these activities is in question. His research involves the application of a "materials balance" approach adopted from physics. D'Arge is continuing his studies of basic theories in economic resources allocation and growth under RFF sponsorship.

Another conference paper was prepared by Robert U. Ayres, formerly an RFF visiting scholar and now vice president of International Research and Technology Corporation. Ayres uses an approach somewhat similar to that of d'Arge but at a more detailed and therefore less comprehensive level. He examines the ways in which the volume and type of waste residuals are influenced by the nature of the production processes used and the character of the products produced; presents some illustrative applications to certain industrial processes; and suggests how this approach could be used to make projections of residuals generation and discharge. RFF is continuing to support this line of work through research agreements with Ayres' organization. In the next phase an attempt will be made to project residuals discharges by using a computer model.

A third paper, by John Krutilla, Charles Cicchetti, A. Myrick Freeman, and Clifford S. Russell, deals with the special problem of irreplaceable natural assets and includes a detailed analysis of the relative economics of alternative uses of the Hells Canyon of the Snake River. Further discussion of this line of work appears in the section on natural environments.

Additional work dealing with economic growth in the face of finite resources includes two books that are in press and a report on energy conversion. One of the books, a monograph by Allen V. Kneese, Robert Ayres, and Ralph d'Arge, discusses the implications of the materials balance–general equilibrium approach to resources allocation problems. This approach is based on the idea that the amount of residuals (measured in weight or energy) returned to nature as waste residuals must be equal to that embodied in the natural resource inputs used in production and consumption, except for that part accumulated in the system. The return of residuals is usually to common property resources and is therefore unpriced in the ordinary course of market exchange. The monograph, published under the title *Economics and the Environment*, explores the research and policy significance of these issues.

The second book, *The Outlook for Water: Quality, Quantity, and National Growth*, by Nathaniel Wollman, dean of arts and sciences at the University of New Mexico, represents the completion of a large project begun some ten years ago. By projecting regional demand and supply of water resources in the United States through the year 2020, Wollman points up the magnitude and urgency of water quality problems. He also identifies quantitative shortages in several regions, and discusses alternative policies for dealing with problems of both quantity and quality. The book contains methodological contributions in connection with analyzing hydrology on an aggregate regional basis and regional analyses of water quality problems.

During the summer, William Frisken, a physicist from Case Western Reserve University, spent two months as an RFF visiting scholar, working on the potential climatic effects of worldwide energy conversion. He addressed such questions as the effects on climate of carbon dioxide, particulates, and waste heat rejection, and prepared memoranda for use in further RFF study of the many aspects of environmental quality.

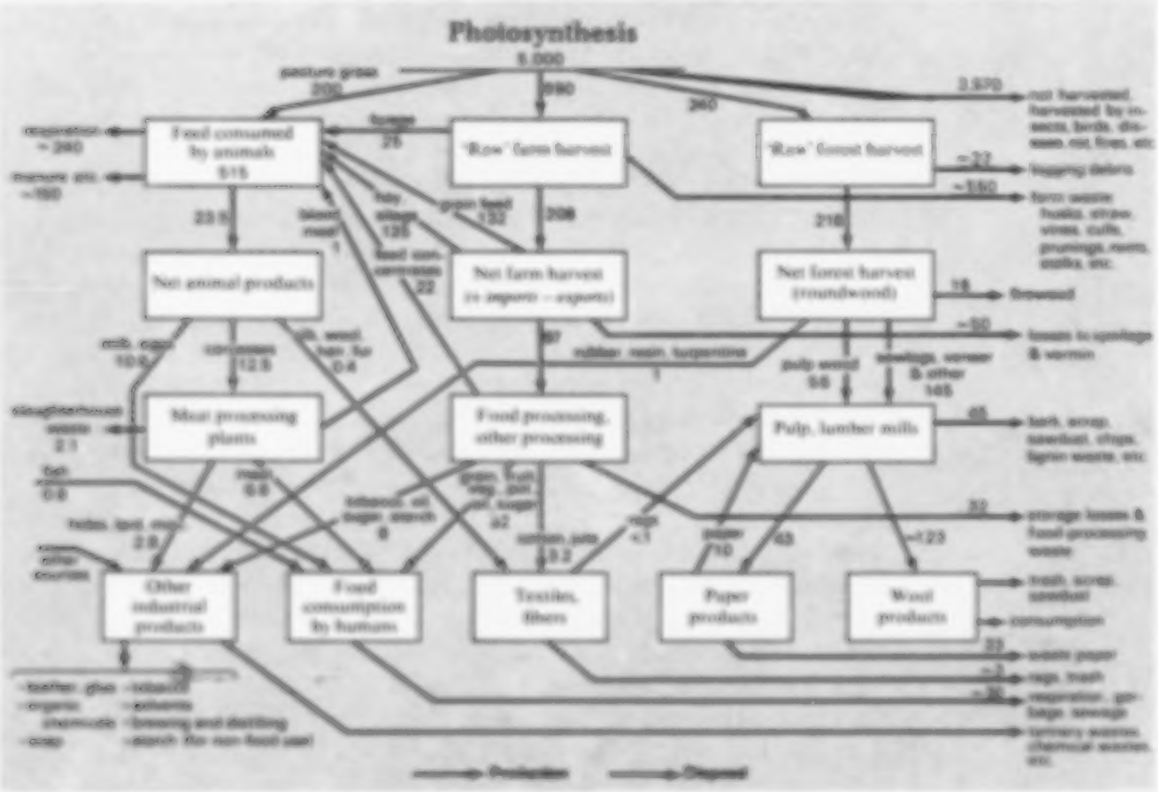
RESIDUALS MANAGEMENT

A conference paper prepared by Clifford Russell and Walter O. Spofford, Jr. presents the first detailed report on a major staff project aimed at building a quantitative regional model for the analysis of overall residuals management. The master model devised by Russell and Spofford contains submodels of production and consumption activities, treatment of residuals, discharge of residuals, dispersion and degradation of residuals in the environment, effects on receptors, and mechanisms for feeding back information for decisions into the production-consumption-treatment segment. Russell and Spofford are now completing a report describing their quantitative model which has been coded for computer application. The next phase of the project will be a regional case study using this analytic structure (see page 44).

A paper by Max R. Langham, associate professor of agricultural economics at the University of Florida, Joseph C. Headley, associate professor of agricultural economics at the University of Missouri, and W. Frank Edwards, assistant professor in the Graduate School of Business at Wake Forest University, discusses two studies that analyze benefits and costs of pesticide use in U.S. agriculture. A technique is developed for estimating the trade-offs between pesticides and other production inputs, and a case study is presented on the economics of pesticides use and control in Dade County, Florida. During the year, Langham and Edwards completed a manuscript on their work in Dade County, and Headley completed a draft report on his work concerning the productivity of pesticide use in American agriculture.

In another paper, Lester B. Lave, associate professor of economics at the Carnegie-Mellon University, addresses the general question of how social damages from deteriorating common property resources can be evaluated, and as an example uses health damage caused by polluted air. Essentially this is a summary report on several years of RFF-supported research at Carnegie-Mellon dealing with the effects of air pollution on health. Other reports on this work include an article by Lave and E. P. Seskin, who is a graduate student at Carnegie-Mellon, entitled "Air Pollution and Human Health," published in the 21 August 1970 issue of Science. It is expected that the next phase of the research will involve a large amount of econometric and statistical work.

Complementary work on the relationships between air pollution and chronic diseases is being done at the University of Pennsylvania with RFF support. Ralph J. Hickey of the Institute of En-


Photosynthesis
5,000
pasture grass 200
890
360
3,970
not harvested, harvested by insects, birds, disease, rot, fires, etc.
respiration ~260
manure etc. ~150
Feed consumed by animals 515
forage 25
"Raw" farm harvest
"Raw" forest harvest
~37
logging debris
~550
farm waste husks, straw, vines, culls, prunings, roots, stalks, etc.
23.5
blood meal 1
hay silage 125
grain feed 132
feed concentrates 22
208
210
Net animal products
Net farm harvest (+ imports − exports)
Net forest harvest (roundwood)
18
firewood
~50
losses to spoilage & vermin
milk, eggs 10.6
carcasses 12.5
silk, wool, hair, fur 0.4
97
rubber, resin, turpentine 1
pulp wood 56
sawlogs, veneer & other 145
slaughterhouse waste 2.1
Meat processing plants
Food processing, other processing
Pulp, lumber mills
65
bark, scrap, sawdust, chips, lignin waste, etc.
fish 0.6
meat 6.8
tobacco, oil, sugar, starch 6
grain, fruit, veg., fats, oil, sugar 42
hides, lard, etc. 2.8
cotton, jute 3.2
rags <1
paper 10
43
~123
32
storage losses & food processing waste
other sources
Other industrial products
Food consumption by humans
Textiles, fibers
Paper products
Wood products
trash, scrap, sawdust
consumption
23
waste paper
~3
rags, trash
~36
respiration, garbage, sewage
tannery wastes, chemical wastes, etc.
-leather, glue
-organic chemicals
-soap
-tobacco
-solvents
-brewing and distilling
-starch (for non-food use)
Production
Disposal

Production and disposal of the products of photosynthesis. The chart is based on one appearing in RFF's new book, Economics and the Environment. *It disregards fossil fuels, which are treated separately. All figures refer to millions of tons of dry organic matter.*

vironmental Studies and David E. Boyce, assistant professor of regional science and transportation, are examining this question with special attention to the physiological mechanisms that may account for health damage. A major report on their work, "Ecological Statistical Studies Concerning Environmental Pollution and Chronic Disease," was published in the October 1970 issue of *Transactions on Geoscience Electronics* of the Institute of Electrical and Electronics Engineers.

Another conference paper, prepared by A. Myrick Freeman of Bowdoin College while a visiting scholar at RFF, investigates how damage due to environmental deterioration tends to become distributed among different income classes and to what extent this should be considered in making policy decisions. Further work on this question is being done by the Regional Plan Association of New York under a research agreement with RFF made during the year. The study will focus on the New York metropolitan region.

A grant of $58,000 was made to Cornell University in support of work on the problem of noise management. Daniel P. Loucks, associate professor of water resources engineering, and Paul B. Williams, a research associate who is spending a year at RFF, will construct alternative noise management models and approaches, for which they will develop data on noise reduction costs and benefits. Later they intend to apply management methodologies to specific community noise problems.

One of the substantial areas of work on residuals management concerns residuals from industrial operations. A research agreement was made with The Center for the Environment and Man, Inc. to support work by Frank A. Smith on the materials recycling industry. This is a survey project intended to improve, at both conceptual and empirical levels, the understanding of residuals recycling industries. Included are such industries as waste paper, wool reprocessing, oil re-refining, secondary metals, and glass, among others. It is hoped that Smith's survey will lay a groundwork for more systematic research on these industries.

In the meantime, two particular residuals recycling industries are being studied with RFF support. A study of the technology, economics, and waste residuals problems of the wool reprocessing industry is being conducted by Robert Ayres under an RFF research agreement with the International Research and Technology Corporation. Another study has been started by Thomas H. E. Quimby, who joined RFF as a visiting scholar during the year. Quimby is studying the technical and marketing factors that bear on the recycling of waste paper and is using the Washington metropolitan area as the focus of a case study. These studies supplement other RFF research into the management of residuals by particular industries. These projects, which include investigations of the pulp and paper, petroleum refining, and canning industries, are under the general direction of Blair T. Bower, associate director of the quality of the environment program. The canning study is being done under a research agreement with the National Canners Association.

An RFF study exploring alternatives to the internal combustion engine in vehicle propulsion systems was completed during the year. Steam and electrical propulsion systems, as well as modifications of the internal combustion engine, are examined by Robert Ayres and Richard P. McKenna in the search for ways of reducing air pollution. A manuscript is being prepared for publication under the title "Alternatives to the Internal Combustion Engine: Impacts on Environmental Quality."

In the general area of urban environmental problems, Resources for the Future has made a grant of $9,700 to Harvard University in support of a study which explores ways of applying systems analysis to these problems. Robert P. Burden, assistant to the dean of engineering and applied physics at Harvard, is directing the project.

DESIGNING POLITICAL AND LEGAL INSTITUTIONS

A conference paper by Edwin T. Haefele of RFF reviews recent developments in the analysis of public and collective choice mechanisms. Several methodological tools for evaluating the results of collective choice mechanisms are discussed and applied to some actual cases of existing or proposed regional environmental management institutions. (The article on page 23 presents some of the conclusions reached in this paper.) Haefele finished two other papers on closely related topics during the year. One was published in the Spring 1970 issue of *Public Choice* under the title "Coalition, Minority Representation, and Vote-Trading Probabilities." The other, "A Utility Theory of Representative Government," is scheduled for publication in *American Economic Review* next spring.

Another conference paper was prepared by Joseph L. Sax, professor of law at the University of Michigan, while a visiting scholar at Resources for the Future. It provides insights into ways in which the law may play a role in the allocation of common property resources — especially by forcing a fuller examination of alternatives than would occur without its intervention. Special attention is directed to developments in the "public trust doctrine" and to the limitations of the government agency intermediaries in their efforts to protect the public interest. While at RFF, Sax completed work on a book that is being published by Alfred A. Knopf under the title *Defending the Environment.*

The final paper in the conference series is by Delbert Miller, professor of sociology and business administration at Indiana University. Miller has applied the research techniques used for studying community power structure to a much larger and more complex area than has been addressed before — the East Coast megalopolis. The chief aim of his research has been to identify those individuals and institutions that could provide leadership in effectively dealing with the region's complex environmental problems. (A somewhat longer discussion of this research is available from RFF in limited quantities upon request to the quality of the environment program.) The paper also touches on some findings for a subregion — the Delaware River Basin — which is being studied by two of his students at Indiana University. RFF made a supplementary grant of $6,800 to the university this year to support additional work on this subject.

During the year, a grant of $25,300 was made to Harvard University in support of research to increase understanding of the political process; how it works at local and regional levels and how its performance might be improved. This research, undertaken by John E. Jackson, assistant professor of government, will relate environmental quality issues to the structure and decision-making process of local governments. As such, it is closely tied to Haefele's more general work on political theory.

The quality of the environment program is designed to carry out and sponsor projects that are not only valuable in their own right but also contribute to a broader program of research. At some appropriate stage, then, a comprehensive report can be made on a problem area and on the economic, technologic, ecologic, and institutional factors affecting it. One way to achieve a tighter integration of results from a number of lines of research is to bring them to bear on a particular region or regions. At the close of the program year, the staff was starting to collect data for a case study of residuals management — its technical, political, economic, and ecologic aspects — in the Delaware Valley area. Insofar as is practical we shall bring to bear on this study the results of our theoretical and empirical work; try to understand the technical options available in the area in terms of their benefits, costs, and distributional effects; and assess the capability of political institutions for coming to grips with the problem in an effective and efficient way. This effort will take several years.

◆

NATURAL ENVIRONMENTS

Many of the problems of environmental quality — including the difficulty of comparing land and water uses that can readily be priced with those that cannot — apply also to the preservation and use of natural environments. The latter, however, also present a unique set of issues that arise from the uneven effects of technological advance.

Natural environments such as wilderness, wild rivers, and scenic areas are irreproducible gifts of nature that can be enjoyed for their aesthetic and recreational value or serve as sites for scientific research. They can be used just as they stand; in fact, they must not be changed. No known technology can create new ones at least within a human lifetime, perhaps never. The main effects of technology, through increased leisure and mobility, will be to increase the demands on such areas.

On the other hand, nearly all natural areas have alternative uses as sources of food or raw materials of industry. In such uses, technological gains are a potent influence; better methods of mining, forestry, and processing make it possible to obtain more materials from more places or to ease the pressure on scarce materials through substitution.

Thus, the continuing advance of technology will decrease the opportunity cost of maintaining a given area in its natural state and increase the value of preserving it. Moreover, although a natural area can always be converted to a source of materials at any time, it is almost impossible to change it back again. Preservation keeps the option open.

Little is yet known about the criteria for making the right decision. In addition to a number of specific problems, much of RFF's current research in the field of natural environments, under the direction of John V. Krutilla, is concerned with this central problem: the impact of technological progress upon the relative value of natural areas as nature preserves or as sources of primary commodities.

Technological Progress and Nonpriced Services

While on the RFF staff during the program year Robert Haveman, now professor of economics at the University of Wisconsin, investigated the relationship between technological progress and the utilization of nonpriced services provided by the natural environment — primarily such common property resources as the waste-assimilative capacity of the earth and air mantle, inland waters, and the recreational services associated with aesthetic attributes of the landscape. In the course of the study a functional taxonomy of common property resource types has been developed and analysis of the sources of, and motivation for, technological progress has been completed. With Charles Cicchetti, work has been started on developing a simplified three-sector simulation model designed to illustrate the welfare effects of the differential incidence of technological progress among three broad sectors of the economy.

In a more purely theoretical approach to the problem, V. Kerry Smith is investigating the differential incidence of technological change upon the demand for and supply of natural resource services. His work is supported by an RFF grant of $8,100 to Bowling Green State University, where Smith is assistant professor in the

Department of Quantitative Analysis and Control. His objective is to establish rigorously the conditions which must obtain for systematic differences to occur in the rate of technological progress among different sectors of the economy, as a first step toward an empirical investigation of the presence of such conditions.

The Optimum Use of Natural Areas

A decision to retain lands in a wild or natural state rather than opening them up to exploitation by extractive industries is only one part of the general problem of efficient resource allocation. When a site is endowed with irreplaceable natural features, and exploitive uses will destroy those features, the problem takes on a much greater complexity. Increases in material wealth and leisure can result in a rate of growth in the demand for the amenity services of natural environments that changes the relative balance between exploitation and preservation of natural areas. With irreversibilities as the nub of the problem, there may be at any particular time a too rapid exploitation of natural resources drawing on the natural environment.

For the investigation of the implications of these relationships, a grant of $7,200 was made to Brown University. Anthony Fisher, assistant professor of economics, is employing the methods of optimal control theory to address the question posed by irreversibilities under a number of assumptions with respect to the character of the future demand for amenity services of natural environments. In August, Fisher presented some of the results of his study in a paper, "Optimum Use of Natural Areas," before the annual meeting of the Western Economics Association. Further work involving the introduction of uncertainty into the analysis has begun.

Alternative Uses of Hells Canyon

Krutilla and Cicchetti, serving as consultants for the Federal Power Commission, completed an analysis of the economics of alternative uses of the Hells Canyon. Results of the study were presented in testimony before the Federal Power Commission's rehearing during the year. The Commission had licensed the Canyon for development in 1964, but its action was challenged in the courts by the Secretary of the Interior. In 1967 the Supreme Court remanded the case to the Federal Power Commission for rehearing, directing that in the light of the Canyon's outstanding natural features the Commission should consider the issue of whether the Canyon should be developed at all. The case now rests before the Commission for decision.

The Hells Canyon analysis and further work contributed by A. Myrick Freeman and Clifford Russell later became the basis for a paper, "Observations on the Economics of Irreplaceable Assets," presented at RFF's conference on environmental quality research. [See page 40.]

As an outcome of these studies, Cicchetti and Freeman have investigated the special issues that should be resolved when a decision regarding the disposition of a natural environment must be made and could result in an irreversible loss of a natural area. In so doing, they were able to justify the definition of "option value" as a value separate from and additional to the usual concept of consumer surplus. Cicchetti also engaged in a study of recreation planning in the public sector.

Classification of Aquatic Environments

Preservation of natural areas for recreation, scientific research, and other purposes requires a means of distinguishing among different types of environments, so that specimens of every type can be retained in the interest of biological diversity and the full range of recreational opportunities, without needless replication of common types. Classification of terrestrial environments has made considerable progress in recent years, but the task of classifying aquatic environments has lagged. While a visiting scholar with RFF during 1968-69, Andrew Sheldon, an aquatic ecologist who is now in the department of zoology at the University of Montana, considered methods of differentiating and aggregating aquatic environments for resource management purposes. During the 1970 year, Sheldon completed a study in which he utilizes the techniques employed in numerical taxonomy, but modifies and further develops them so as to meet the particular requirements of aquatic environment classification.

Aesthetic Dimensions of the Back-country Landscape

Visual attributes of the landscape, as well as the land itself, yield services, but only recently has an effort been made to identify, analyze, classify, and evaluate scenic resources. Working under an RFF grant to the University of California at Berkeley, R. Burton Litton, Jr., professor of landscape architecture, completed a pioneer study this year. Litton has identified landscape types by composition and analyzed their characteristics from the perspective of various recognition factors. Collaborating with him, Kenneth Craik, assistant professor of psychology and assistant research psychologist at the University, has tested the objective validity of Litton's perception of the aesthetic dimensions through the use of samples drawn from different groups — academic versus nonacademic, and design student versus general education student, for example. A manuscript, completed during the year, is undergoing review.

The Pacific Flyway

In a study of the migratory waterfowl of the Pacific flyway, Judd Hammack and Gardner Brown of the University of Washington have established the existence of a marginal net value for migratory waterfowl, derived from the institutional restraints on unrestricted recreational hunting, and have also estimated that value for dabbling ducks. Through the use of data on mallards, they have developed a breeding population model which would maximize the harvest for a dabbling duck species. The empirical results, both economic and ecological, are then used to identify and clarify costs and benefits connected with waterfowl and the recreational activity they support. The usefulness of waterfowl value data for the valuing of wetlands used as nesting grounds is illustrated in the study, which was completed during the program year.

This research has been supported by a grant to the University of Washington.

Competition for Wetlands in the Midwest

A study on the competition for use of wetlands in the prairie pothole regions was completed by Jon Goldstein, an economist who began the study while an RFF Fellow. At the end of the program year his book was in press. Goldstein has analyzed a classical resource allocation problem: how best to utilize a scarce resource offering possibilities for alternative but incompatible uses. On the one hand, the wetlands, when drained, have value as productive agricultural land; on the other, they have value as a vital part of the ecology of migratory waterfowl and as cover and a food source for fur-bearing animals. Continuing use of the prairie pothole region by the migratory waterfowl of the Central and Mississippi flyway is threatened because drainage subsidies are inducements to farmers to drain temporary wetlands.

In his study of this problem Goldstein found also that the well-established agricultural price support programs currently serve as strong incentives to farmers in some of the lower-cost drainage areas to convert permanent wetlands to cropland. Goldstein suggests policy alternatives with a view to designing incentives to produce the proper allocative decisions without endangering other possible objectives of various agricultural policies.

Water Resources

Since its inception in 1953, RFF's water resources program has stressed the relevance of social science research to effective development and management of water resources. By now the usefulness of this type of research is widely recognized. In recent years, federal, state, and local agencies of government have encouraged an enormous amount of basic and applied research. In addition to work on engineering, hydraulic, and hydrological aspects of water management, greater emphasis is being placed on analyses of the social and economic impacts of water resource projects. This is reflected by an increasing number of grants from such groups as the Interior Department's Office of Water Resources Research in support of studies dealing with the processes by which water allocation decisions are made, perceptions of and reactions to water availability and water quality, and urban water use.

Basic work at Resources for the Future has helped point the way to improved planning procedures, which currently are being implemented on a large scale. Today it is evident that more effective water allocation and use decisions can be made if water resources planning is viewed as a component of natural resource planning generally, and one which must be synchronized with land use planning. Thus, RFF's future work on water resource problems will take something of a new turn, attempting to relate both water and land uses to evolving demands and social needs. In a sense, then, the past year marks the "wrapping up" of a number of lines of research in water resources, although projects currently under way will continue to completion.

PLANNING AND MANAGEMENT

Groundwater Management

Last spring Robert A. Young of the RFF staff and John Bredehoeft of the United States Geological Survey completed a pioneering set of investigations concerned with the rational management of groundwater in conjunction with surface supplies. Computer models of regional economic activity were combined with detailed models of groundwater storage systems to permit the evaluation, in both economic and hydrologic terms, of different systems of groundwater allocation.

The first part of the study deals with a large aquifer system and agricultural activities representative of conditions in central Arizona. The model shows that unrestrained pumping from the aquifer, which is likely to occur if individual behavior is determined by profit maximization, is far from optimal from the viewpoint of maximizing the present value of net incomes to the area. A restricted pumping scheme of the type that would result from the adoption of individual farm quotas or the imposition of a pumping tax greatly increases the incomes generated over time to the area as a whole. Another important finding is that the amount of water from the aquifer that can be utilized (and hence the aquifer's economic value) is sensitive to the location at which pumping occurs.

The second part of the study deals with a narrow alluvial aquifer in close proximity to a river, offering examples of situations in which pumping and river flow are intimately connected. The objective of this part of the study was to determine approximately optimal rules for allocating water between activities drawing directly from the river and those pumping from the related aquifer.

A report of the first part of the study was published in the February 1970 issue of *Water Resources Research*.

Analysis of Project Performance

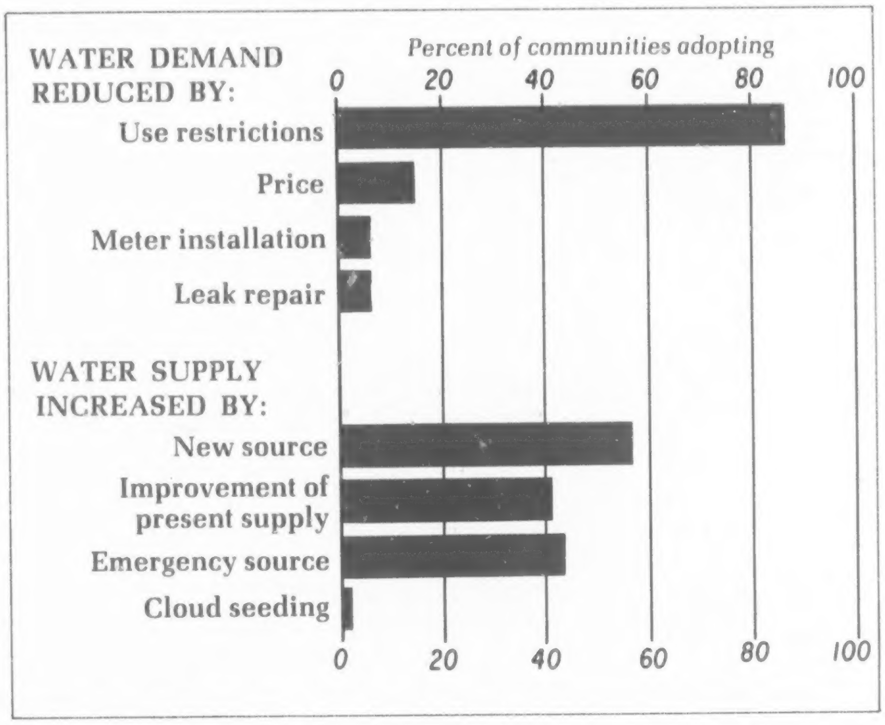
In another project relating to planning and management procedures, Robert H. Haveman has analyzed the usefulness of evaluations of water resource project performance and procedures for carrying them out. Lack of such evaluations has been one of the major shortcomings of public expenditure policy in general and of water resource development in particular.

Haveman treats the problems involved in assessing, at a point in time, whether or not a project has lived up to the benefit-cost standards predicted for it prior to the time of construction. Navigation, flood control, and power are given particular emphasis.

Procedures for incorporating the findings of such analyses into improved benefit-cost analyses are also discussed in Haveman's manuscript, which was under review at the end of fiscal 1970.

Drought and Urban Water Supply Planning

A book resulting from a study of the impact of the 1963-66 drought on New England cities, conducted by Clifford S. Russell of the RFF staff, David Arey of the University of Pittsburgh, and Robert Kates of Clark University, was in press at the end of the program year. In *Drought and Water Supply: Implications of the*



Adjustments to the drought of 1963-66 included planned reduction in demand for water as well as efforts to increase its supply. The chart shows how these adjustments were made by thirty-nine Massachusetts communities. It is based on a chart in RFF's new book, Drought and Water Supply.

Massachusetts Experience for Municipal Planning, the authors develop a methodology for measuring drought losses and incorporating the resultant loss functions in planning the optimal additions to a city water supply system.

Water Transfers

Water transfers can take place between uses or between regions. Two studies have been completed dealing with the economics of both types of transfers.

Water Transfers: Economic Efficiency and Alternative Institutions, by L. M. Hartman and Don A. Seastone, was published early in 1970. The book is concerned with the impacts of transfers between uses and the implications of including effects on third parties in carrying out appropriate benefit-cost analyses. The authors also treat the subject of alternative institutions for managing water and facilitating appropriate transfers.

A book by Charles W. Howe and K. William Easter, *Interbasin Transfers of Water: Economic Issues and Impacts,* was in press at the end of the program year. This study develops procedures for evaluating proposed transfers, points out a number of viable alternatives to such transfers, and indicates the types of information that are critical to the appropriate assessment of these very large projects.

BASIC THEORY OF RESOURCE ALLOCATION

From time to time, the opportunity arises to support fundamental work on some aspect of the theory of optimal allocation. During the year, a trail-blazing study entitled *Public Investment, The Rate of Return, and Optimal Fiscal Policy,* by Kenneth J. Arrow and Mordecai Kurz, was published. The authors tie the allocation of resources between public and private sectors of an economy to the goal of getting the economic system on an efficient growth path. A theory of "controllability" is developed and the adequacy of various fiscal tools to bring about an optimal intertemporal allocation of resources is assessed. The study promises to influence developments in the theory of public finance for a long time.

Further theoretical research on the theory of optimal expenditure is being continued by Stephen A. Marglin and Elisha Pazner at Harvard. The major question addressed is the magnitude of welfare losses incurred when resource allocation and income distribution policy decisions are treated as separable and are made independently.

A third theoretical study is being pursued by Andrew Whinston, professor of economics and management, under a grant of $8,000 to Purdue University. This work focuses upon the financing of public investment. Although past research has shown how to design a minimum cost water treatment system to meet regional water quality goals, little attention has been given to how the construction and operation of such a treatment system is to be financed, or to the question of how to set correct water quality goals. Whinston is concentrating on these two issues.

TECHNOLOGY AND WATER DEMAND

During part of the year Charles Howe, Clifford Russell, and Robert Young worked on a study of the impacts of technology on water demand. This study was undertaken by RFF for the National Water Commission.

A draft report completed in July consisted of three sections: urban water demands, industrial water demands, and agricultural water demands. Consideration was given to selected activities and topics within each of these sectors, with emphasis on tracing the impacts of changing technology, changing market conditions, and possible changes in relevant public policies on water demands from 1970 through 1990.

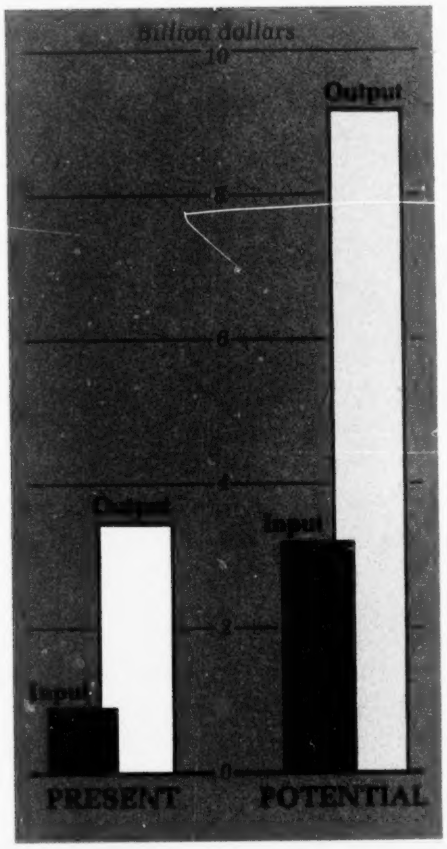
Land Use and Management

Six studies completed during the year covered a wide range of land use problems both in the United States and abroad. Major findings of one of them — on the disposal of resources from the public lands — have been published in professional journals or as congressional testimony. Two of the others were in press at the close of the year, and the manuscript of another was being edited. In May, RFF held a conference to discuss some of the problems and opportunities facing nonmetropolitan areas in the United States and the issues of national policy that they present. Two new grants were made: one to facilitate a conference in November 1970 on the U.S. timber supply issues, and one for a study of the temporal allocation of resources, with particular application to investments in soil conservation.

FOREIGN AGRICULTURE

Agricultural Potential in the Middle East

A report on the agricultural potential of the Middle East, by Marion Clawson, Hans H. Landsberg, and Lyle T. Alexander, was sent to press, and is scheduled for publication early in 1971 by the American Elsevier Publishing Company. The book, one of a series of Middle Eastern studies undertaken jointly with The Rand Corporation with the support of a special grant from the Ford Foundation, presents a detailed survey of the natural resources of Middle Eastern countries as they affect agriculture, and on the utilization of those resources. Agricultural development possibilities of the area are analyzed against this background. An extended statistical appendix includes historical data on crop acreages, yields, and production; livestock numbers and production; farm inputs of various kinds; and farm output for as many years and in as much detail as was possible for each country. Another appendix describes the soils of the Middle East, and two special maps at the end of the book present a picture of soil conditions that has not previously been available.



The value of Middle Eastern agricultural output could almost triple if fertilizer, machinery, pesticide, and other inputs were increased to the extent shown and efficient farming practices were adopted. The chart is based on data presented in the new RFF-Rand book, The Agricultural Potential of the Middle East.

One of the findings of the study was that the Middle East has the physical potential for large increases in agricultural output over the next twenty to thirty years, ranging from perhaps a 50 percent increase in Israel, where agriculture is already highly developed, to as much as a tenfold increase in Iraq, where agriculture now is at a relatively low level but natural resource availability is high. This potential cannot be obtained, however, without the application of modern farm technology and management, accompanied by a relaxation of restrictions and rigidities in the political, social, and institutional fields. Although outside help will be of value, especially in the initial stages, nearly all of the ingredients for agricultural success in the Middle East must come from within the region. As the authors see it, agricultural progress will either capture the imagination of the country and become a primary objective of its government, or it will not take place.

Desalting Seawater

During their study of Middle Eastern agriculture, Clawson, Landsberg, and Alexander became interested in the economics of desalting seawater for commercial agriculture and published an article on general aspects of the subject in the June 1969 issue of *Science*. In the 1970 year, Clawson and Landsberg brought together a group of articles, reports, and excerpts from congressional hearings as a book of readings on the outlook for desalting seawater. The writers whose work is represented in this collection fall into three major groups: (1) the describers or explainers, who seek primarily to provide information about some experience or situation; (2) the proposers, advocates, or promoters, who advance ideas about possible future seawater desalting plants of a size, type, and method of operation that have no counterpart in any plant today, but are considered to have great potential for the future; and (3) the critics, who see the great possibilities of desalting seawater as a means of meeting serious water problems in many parts of the world, but are highly dubious about the economics of the various proposals. The book, *Desalting Seawater—Achievements and Prospects*, was in press at the end of the year and is scheduled for publication early in 1971 by Gordon and Breach, Science Publishers Inc.

The Mekong Basin

In response to a request by the International Bank for Reconstruction and Development, a group of RFF staff members reviewed the numerous surveys and planning studies that have been made for the Lower Mekong Basin. By year's end, their findings on the direction, nature, and rate of optimum resource development within the Basin had been reported to the Bank. Michael F. Brewer, Marion Clawson, Hans H. Landsberg, Pierre Crosson, John V. Krutilla, and William J. Vaughan, all of RFF, contributed to the study, as did Jasper Ingersoll, Department of Anthropology, Catholic University, and Nancee Black, who were recruited for the project.

The Mekong is one of the world's great rivers; the volume of its flow is large but highly variable seasonally, and in the course of its flow in the lower basin it descends several hundred feet. The possibilities of hydroelectric power generation are great. Although the region has a high rainfall, this is nearly all concentrated in about six months, with a very dry season during which water application to the land would permit growing of additional crops. Flood protection, drainage, and irrigation are integral parts of water management. The region has been torn by warfare and civil unrest since the end of World War II; Cambodia, Laos, and South Vietnam, which gained their independence in this period, have never experienced peace under a national government. The report to the Bank considers and contrasts several paths that development of the basin's agriculture might follow. It also considers problems of proceeding with a development plan in the face of limited information about the physical and especially the social characteristics of the Basin, and suggests how a strategy of development might be adopted to contend with such a situation.

SUBURBAN EXPANSION

Suburban Expansion in the United States

At the year's end, a manuscript on suburban land conversion in the United States as an economic and governmental process was sent to press. This study, by Marion Clawson, is the culmination of a major research project which has investigated various aspects of urban expansion. The processes of suburban land conversion are complex, with many groups or organizations participating in the decision-making process. Suburban land conversion, as it has operated since the close of World War II, is often criticized for having kept lower-income people and racial minorities out of the suburbs and out of new housing generally; and for having been too expensive in terms of the housing it has produced and of the groups that it has served. These deficiences, for which developers, local governments, and the federal government have all been blamed, are shown to be a natural outgrowth of the suburban land market and of the public and private processes of decision making.

The book includes a general discussion of the complex relationships of the suburban land conversion process; a more detailed examination of the situation in the northeastern urban complex; some projections for the future; and a number of suggested measures which, singly or in combination, might change the nature of the suburban land conversion process and of its results. The position is taken that the usual methods of land planning and zoning must be supplemented by other and stronger actions if there is to be any significant change.

George A. McBride, who was associated with this project from 1966 to 1969, and Marion Clawson reported some of the findings in "Negotiation and Land Conversion," which appeared in the January 1970 issue of the *Journal of the American Institute of Planners.*

Urbanization in England

A companion study on urbanization is being carried out in England by the Political and Economic Planning organization of Great Britain with some support from RFF. This effort also moved forward significantly during the program year. Publication of a bulletin, *Aycliffe to Cumbernauld — A Study of Seven New Towns in*

Their Regions, by Ray Thomas, rounded out the study of new towns established in or before 1955. In an earlier bulletin Thomas reported that the eight London new towns, which were part of a well-considered regional development strategy, had on the whole succeeded in meeting the objectives of that strategy. The seven provincial new towns reported on this year have experienced much more uneven success, possibly because they had neither a common planning base nor in some instances any apparent agreed-upon purpose.

By the end of the year, work on a comprehensive report on urbanization in England was nearing completion. Research by Peter Hall, the principal investigator, and by Ray Thomas, Roy Drewett, and Harry Gracey has produced an unprecedented range of historical and geographical detail on planning efforts and their results, the form of urban expansion and its consequences, the nature of the housing and its cost, the nature and intensity of suburban land use, and the problems of urban transportation.

Hall and Clawson, the principal authors of the British and U.S. studies, are planning a short book that will compare the nature of the urban growth process in the two countries, with emphasis on its land-using aspects and the role of government in that process.

Agriculture and Rural Life

Resources for the Future convened a small group of scholars from a wide variety of professional fields, in early May 1970, to discuss some of the problems and opportunities facing rural areas. It was concluded that "nonmetropolitan" is more descriptive than "rural" because the smaller cities and towns lying outside the economic orbit of the larger metropolitan centers face many of the problems that confront the strictly rural areas. Although there is considerable variation within the nonmetropolitan areas, on the whole their populations are growing more slowly, they are losing more of their able young people through migration, average incomes are lower, living conditions are poorer, and social services of all kinds are inferior, as compared with the average of the metropolitan areas. The conference felt that one set of policy issues was concerned with the extent, if any, to which national policy should be directed toward reducing the growth rate of metropolitan areas and increasing the growth rate of nonmetropolitan areas; it was concluded that this would be a difficult operation, if undertaken. Another set of policy issues revolved around the matter of the optimum pattern of settlement on the land in the nonmetropolitan areas.

As a result of the conference, RFF has arranged with L. T. Wallace of the University of California to prepare a monograph on the subject, utilizing the draft statement prepared for this conference as a starting point.

DOMESTIC AGRICULTURE

Resource Allocation in American Agriculture

A manuscript on resource allocation and use in American agriculture from World War I to the late 1960s, prepared under the direction of Glenn L. Johnson, was under review at the end of the program year. This study is the outcome of a long-term project, which was partially supported by an RFF grant to Michigan State University, supplemented to a very considerable degree by university funds. A number of doctoral dissertations were prepared as part of this program, and seven former graduate students collaborated with Johnson in preparation of this manuscript. A theoretical framework was developed, and empirical data were assembled to test and illustrate it. The result is a comprehensive and incisive quantitative analysis of agriculture, which points up the persistent tendency toward over-production in this period and the resultant diminished returns to the factors of production.

Economic Analysis of Range and Soil Conservation

Despite the long history of soil conservation in the United States and the variety of costly programs in range and soil conservation that have been adopted by both federal and state governments, there has been little rigorous analysis of the central economic issue of how to invest most efficiently in increasing soil productivity. Developing an economic framework that can be used for assessing such investments is one of the objectives of a study of the temporal allocation of natural resources in general, which is being carried out by Professor Oscar R. Burt of the department of economics and agricultural economics at Montana State University. RFF has made a grant of $19,600 to the University in support of this work.

FORESTRY IN THE UNITED STATES

The Timber Supply Situation

Intense shortages in some forest products and abrupt increases in price in the past few years have focused attention on the supply of timber in the United States and particularly on the supply of lumber. Although conditions are less severe today than they were a year or so ago, only great improvements in technology are likely to permit the resource to satisfy the wants of a soaring population. With a view to finding new approaches that would reflect the desire for both development of supply and the maintenance of environmental quality, the State University of New York College of Forestry convened a conference to discuss the various aspects of the timber situation. William A. Duerr, professor of forestry economics at the college, was to chair the conference, which was scheduled for 23-24 November 1970 at Arden House, Harriman, New York. The invited conferees included representatives of government, the consuming public, conservationists, forestry educational and research institutions, wood-using industry, labor interests, land owners, and other interested groups. Plans called for publishing a digest of the discussion on the problems, the prospects, and the policy implications of the situation, together with the fifteen background papers prepared for the conference. In March 1970, RFF made a grant of $6,000 to the Research Foundation of the State University of New York in partial support of the conference.

Forestry as a Profession

A history of the development of forestry as a profession in the United States was being edited for publication at the year's end. This study was made by Henry Clepper, formerly executive secretary of the Society of American Foresters, with support from a 1966 RFF grant to the Forest History Society.

RESOURCES FROM PUBLIC LANDS

During the year, three papers by Walter J. Meade brought to a total of thirteen the articles or statements resulting from his study of the disposal of resources from public lands and the economic consequences of different methods. The new papers were:

"Mineral Leasing Problems on the Outer Continental Shelf," testimony given 1 April before the U.S. Senate Committee on Interior and Insular Affairs and scheduled for publication in the *Hearings*.

"A National Defense Petroleum Reserve Alternative to Oil Import Quotas" (with Philip E. Sorenson), presented in August to the annual meeting of the Western Economic Association at Davis, California.

"Energy Price Inflation and Interfuel Competition," testimony prepared for presentation 5 October before the Joint Economic Committee of the U.S. Congress and scheduled for publication in the *Hearings*.

In the study, which has been supported by a 1965 RFF grant to the University of California at Santa Barbara, Meade has focused his attention upon oil and gas and oil shale leasing. These are by far the most valuable resources disposed of from public lands, and the policy issues they raise — particularly for the submerged areas and for oil shale — have been particularly active and disputed in recent years.

Earlier findings of the study have been set forth by Meade in the following papers:

April 1967, "Natural Resources Disposal Policy: Oral Auction vs. Sealed-Bidding," *Natural Resources Journal*, vol. 7.

May 1967, "The Use of Competitive Markets in Federal Oil Shale Leasing Policy," *Hearings* before the Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U.S. Senate, 90th Cong., 1st sess., Pursuant to S. Res. 26, part 1. Reprinted in *Congressional Record*, 11 October 1968, S-12564-9.

November 1967, "Natural Resource Pricing Policy — Timber, Oil and Oil Shale," presented at the annual meeting of the Southern Economic Association, New Orleans.

Fall 1967, "The Competitive Significance of Joint Ventures," *The Antitrust Bulletin*, vol. 12.

July 1968, "The Workability of Competition in Federal Oil Shale Leasing," Western Resources Conference, Colorado State University — published in *Public Land Policy*, Phillip O. Foss (editor), Colorado Associated University Press, 1970.

October 1968, "Economic Issues in Federal Oil Shale Leasing Policy Alternatives," *Quarterly* of the Colorado School of Mines, vol. 63, no. 4.

October 1968, "The Structure of the Buyer Market for Oil Shale Resources," *Natural Resources Journal*, vol. 8, no. 4. Reprinted in *Rocky Mountain Mineral Law Journal*.

March 1968, "The System of Government Subsidies to the Oil Industry," *Hearings* before the U.S. Senate Subcommittee on Antitrust and Monopoly on *Governmental Intervention in the Market Mechanism*, 91st Cong., 1st sess. Reprinted in *Natural Resources Journal*, January 1970, and in *National Petroleum Policy*, A. E. Utton (editor), 1970.

June 1969, "The Economics of Depletion Allowance," statement presented to the Assembly Revenue and Taxation Committee, California Legislature, Sacramento.

June 1969, "Federal Public Lands Leasing Policies," paper presented at the Rocky Mountain Petroleum Economics Institute, Colorado Springs. Published in *Quarterly* of the Colorado School of Mines, October 1969.

Energy and Minerals

RFF's program in energy and minerals continues to focus much of its research on issues relating to domestic policy and to international trade and investment. Both areas of study have been important elements in the program for several years. Four new books were in press at the end of the fiscal year. Plans for an October seminar dealing with the regulation of natural gas were completed; and an analysis of world copper production and markets was begun.

In addition, resource adequacy — a persistent question when dealing with a resource base which is finite — is being freshly explored. Although concern about this question is always present, it erupts with particular force from time to time, and brings home the lesson that more needs to be known about the resource base and particularly about the technical and economic aspects of the exploration and development process through which undiscovered (and therefore essentially worthless) minerals in the ground are converted to useful economic resources. Three studies in this area were begun during the year.

Technological advance in resource extraction, conversion, and use is a thread running through all three areas of research, since it is an essential element in almost all of the questions on which research projects are under way.

The direction of the energy and minerals program during the year was divided between Sam H. Schurr and Orris C. Herfindahl. During the period between January and May when Schurr spent much of his time as a consultant to the Research Department of the International Monetary Fund, advising on research needs in international petroleum, Herfindahl was acting director of the program.

BACKGROUND FOR DOMESTIC POLICY

Numerous policies at state and federal levels have a significant impact on the structure and functioning of the energy and minerals industries in the United States. The policies are so diverse in their origins and development that their overall impact in the industries' performance is frequently obscure. Conflicting views are often held within the industries themselves as well as among the government agencies concerned, the scholars who have engaged in specialized analyses, and the general public.

RFF has done considerable research in this area. One result was the publication in 1968 of *U.S. Energy Policies: An Agenda for Research*, an across-the-board appraisal of research needed for the understanding and improvement of energy policies. This study, undertaken at the request of the Office of Science and Technology in the Executive Office of the President, pinpointed several areas in which further research was especially urgent, among them the regulation of natural gas, the regulation of petroleum conservation, and oil import policy. Over the last two years, RFF work in these fields has progressed. In response to a request from OST to extend our research in the field of natural gas regulation, RFF has organized a seminar, for which a comprehensive series of background papers have recently been completed. Work on the regulation of petroleum conservation has resulted in a book scheduled for publication next year. A third project, dealing with U.S. oil import policies, has been temporarily set aside because of the death of Wallace F. Lovejoy, professor of economics at Southern Methodist University, who had been conducting the study. Lovejoy, a longtime university collaborator in the RFF energy program, is the author of other studies RFF has supported.

Regulation of Natural Gas

RFF's seminar on the regulation of the natural gas producing industry, was planned at a time of prevailing concern about stringency in U.S. energy supplies. Some believed a contributing factor to be the regulation of producer prices for natural gas. Prior to the seminar, held in Washington 15-17 October, ten background papers were written to guide discussion. Preparations for the seminar were directed by Keith C. Brown, associate professor of economics at the School of Industrial Administration at Purdue University. Brown will draw on the background papers and on the discussion at the seminar to prepare a report assessing regulatory alternatives for natural gas. The papers, all of which were in draft form by early September, deal with the following topics:

Natural Gas in the Future Energy Patterns
  John J. Schanz and Helmut J. Frank, University of Denver Research Institute

Interfuel Relations Governing Natural Gas Demand and Supply
  Richard J. Gonzalez, petroleum economics consultant

Projected Costs of Alternative Sources of Gas
  R. Bruce Foster, Institute of Gas Technology

Producer Regulation From A Commissioner's Viewpoint
  Charles R. Ross, former Commissioner, Federal Power Commission

Changing Elements in the Natural Gas Picture: Implications for the Federal Regulatory Scheme
  Ralph S. Spritzer, University of Pennsylvania Law School

Structure of the Natural Gas Producing Industry
  Clark A. Hawkins, University of Arizona

The Effects of FPC Area Rates on the Discovery of Gas Reserves in the 1960s
  Paul W. MacAvoy, Massachusetts Institute of Technology

Price, Regulation, and the Supply of Natural Gas in the United States
  Edward Erickson, North Carolina State University

Producer Regulation for the 1970s
  Milton R. Russell, Southern Illinois University

The Future of Natural Gas Regulation Under Conditions of a Major Deficiency in the Supply of Domestically Produced Natural Gas
  James R. Nelson, Amherst College

Petroleum Conservation Regulation

While technical aspects of petroleum occurrence and production bring about general similarities among state conservation regulations, there are important variations in systems of control, some of which are little understood outside the industry. The detailed "waste prevention" regulations governing certain stages in drilling and oil well operation provide examples of these: the gas-oil ratio, reservoir energy, disposal of brine, and plugging of wells. Better known are the various systems of production control (with market-demand proration as a central feature) and the regulation of well spacing.

The effects of conservation controls on the cost and price of oil, on the efficiency of the industry's operations, and on incentives to domestic exploration and development — long the subject of controversy — are dealt with in a study by Stephen L. McDonald entitled *Petroleum Conservation in the United States: An Economic Analysis*. The manuscript went to press in September for publication next year.

The basic standard used by McDonald to compare the results of the various elements in the oil conservation system is the maximum present value of net benefits. From this viewpoint, if the regulations alter the time flow of product and inputs in a way that fails to take proper account of the alternative use of production services, or if they stimulate wasteful outlays that do not result in an equivalent amount of product, the results will be inefficiency and a diminished social product.

The McDonald study complements earlier RFF work done by Wallace F. Lovejoy and Paul T. Homan, published in 1967 as *Economic Aspects of Oil Conservation Regulation;* but the viewpoints are different. The earlier book approaches the subject from the standpoint of the evolutionary development of the systems now employed; in the forthcoming book the approach is more from the standpoint of economic theory, though with a full appreciation of the institutional factors involved.

Research for the study was supported by an RFF grant to the University of Texas, where McDonald is professor of economics.

INTERNATIONAL ASPECTS OF ENERGY AND MINERALS

In this group of studies, three dealing with international energy trends and problems have been completed. Of four other studies concerned mainly with international minerals trends and problems, two have been completed, one is halfway to completion, and one has just begun.

Middle Eastern Oil

A book entitled *Middle Eastern Oil and the Western World: Prospects and Problems*, by Sam H. Schurr, Paul T. Homan, and associates, is in process of publication by American Elsevier Publishing Company. This book is one of two RFF studies resulting from a joint RFF-Rand program of Middle East economic studies. An article setting forth some of its conclusions appears on page 15.

Energy in the World Economy

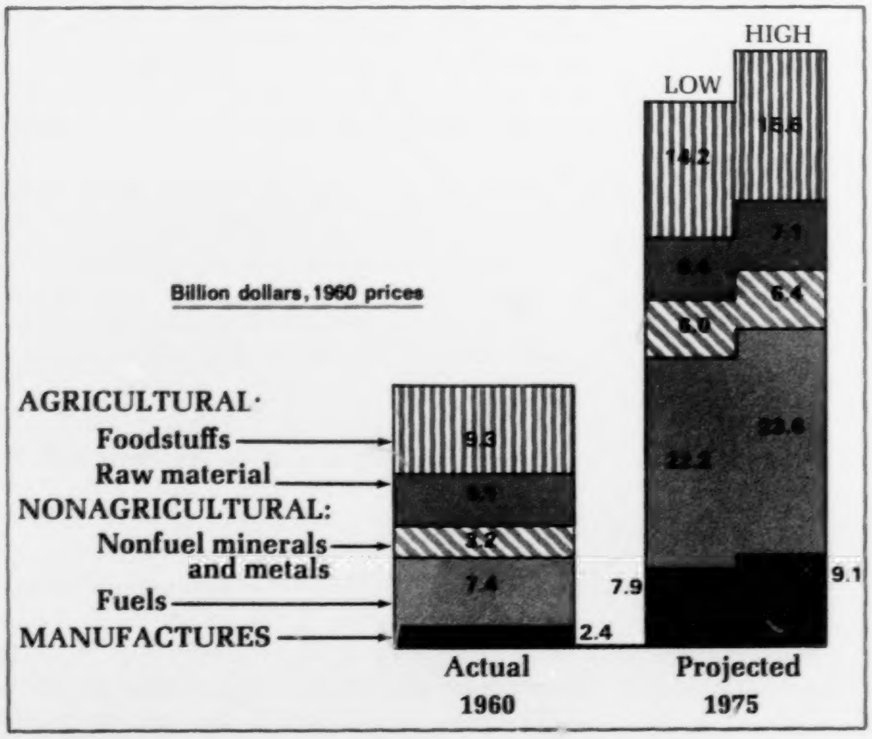
A final draft of "Energy in the World Economy," by Joel Darmstadter and associates, is being edited. The study, which is the outcome of several years of RFF research, traces changes in world energy supplies, consumption, and international trade in geographic detail between 1925 and the mid-1960s. The authors have compiled statistical series showing movements in the consumption, production, and international trade of energy commodities since 1925, by country, region, and for the world as a whole. Drawing on these data an analysis is presented relating the main characteristics of these movements to other economic variables such as population and national product in individual countries and broad regions.

World Petroleum Market

M. A. Adelman's study of the world petroleum market, which has been under way for several years, is ready for editing. The study analyzes the course of oil costs and prices since 1947 and explains the underlying factors. The study has already yielded many useful byproducts in the form of monographs and journal articles. Research was supported by RFF grants to the Massachusetts Institute of Technology, where Adelman is professor of economics.

Investor–Host Country Relations

A study of the relations between host countries and foreign companies investing in extractive industries was in press at the end of the program year. The book, *Foreign Investment in the Petroleum and Mineral Industries*, by Raymond F. Mikesell and associates, consists of a number of case studies of specific situations backed by a general analysis of the problems involved. The case studies deal with oil in Venezuela, Saudi Arabia, and Iran; iron ore in Brazil and Venezuela; and copper in Chile. The more general chapters deal with the nature of the conflicts between foreign investors and host countries, the contribution of resource industries to economic development, the taxation of extractive industries by host countries, and problems of labor relations.



From 1960 to 1975 the value of exports from developing countries is expected to increase at an annual rate running between 5 to 5.6 percent. The chart is based on a table appearing in RFF's new book, Foreign Investment in the Petroleum and Mineral Industries.

Research for the study was supported by an RFF grant to the University of Oregon, where Mikesell is W. E. Miner professor of economics.

World Iron Ore Industry

A study of changing world demand for and supply of iron ore and of changing locations of steel production since 1950 was in press at the end of the program year. The book, by Gerald Manners, Reader in Geography at University College, University of London, results from research supported by an RFF grant to the University College of Swansea. It will be published under the title *The Changing World Market for Iron Ore, 1950-1980: An Economic Geography*.

The Australian Mining Industry

Since 1967 an analysis of the financing and development of the Australian mining industry has been under way, supported by an RFF grant to the University of Melbourne. Research is in progress on the activities of both domestic and foreign firms operating in Australia.

The study is being conducted by P. J. Rose, research fellow, under the direction of Ronald J. Henderson, director of the Institute of Applied Economic and Social Research, University of Melbourne. Rose has already presented some of his findings in "Aspects of Financing the Mineral Industry in Australia," which appeared in the *Australian Economic Review*, Fourth Quarter, 1969.

During the program year RFF made a supplementary grant of $9,500 in support of further work covering recent developments in Australia's swiftly expanding minerals industry.

World Copper Production and Markets

In September Raymond F. Mikesell began a study analyzing recent developments in the structure of the world copper industry and assessing their implications for the future volume and distribution of the world's copper supply. His work is supported by an RFF grant of $20,700 to the University of Oregon.

Nationalization programs in Chile, the Congo, and Zambia, together with increased government control in Peru and other developing countries that produce copper, have raised questions concerning long-run supply. At present the developing countries account for 70 percent of world copper exports. Plans in these areas call for increasing productive capacity; in some cases this is to be financed by the national government alone and in other cases jointly by the foreign investor and the government. However, there are uncertainties regarding the supply of capital and also regarding the technical and managerial ability of the national governments to operate the mines efficiently.

Mikesell will analyze these and other factors relating to the long-run supply of copper. Special emphasis will be given to the effects on the world market of changes in ownership, production control, and marketing policies in the developing areas.

PROBLEMS OF RESOURCE ADEQUACY

Projections of world population growth, and especially of continuing increases in per capita consumption of goods and services, have stimulated widespread public concern for the future adequacy of energy and mineral resources. Once again, the question arises: Are we likely to "run out" of some materials or, more realistically, are we likely to face much higher costs in their extraction and production?

Three studies begun during the program year are related to this question. Two of them are designed to yield statistical approaches to improve the efficiency of minerals exploration; the third examines the possibilities of substitution as a means of easing the pressure on those natural resources in which supply stringencies may be encountered.

Quantitative Appraisal of Mineral Resources

DeVerle P. Harris, professor of mineral economics at Pennsylvania State University, is working on a quantitative appraisal of mineral resources as an aid to improved exploration. He hopes to develop a statistical method for predicting the probable location and quantity of mineral resources by studying the relationships between (1) quantified geological and geophysical characteristics and (2) the known location of past mineral production and present reserves. The method would be applicable to regional rather than more specific exploration prospects.

The study builds on earlier work by Harris. The region to be studied will be mapped in such a way as to insure a high degree of uniformity in interpretation and quality of the geological data and the inclusion of characteristics — such as weak faults and fractures not visible on the ground — that are not found in the usual geological maps. The system will also incorporate some geophysical data, probably on magnetism and gravity.

The study, which is expected also to provide an opportunity for graduate students to become familiar with this line of investigation, is supported by an RFF grant of $41,200 to Pennsylvania State University.

Statistical Models of Mineral Exploration

Research was begun during the program year to develop statistical models of exploration for petroleum. Data from Alberta are being used for simulation calculations. One part of the study is directed toward developing a model for estimating the number and size of oil field discoveries. Another part concentrates on finding a more accurate way of estimating the distribution of financial returns in relation to the distribution of deposits.

The work is being done by Professor Gordon M. Kaufman, of the Sloan School of Management at the Massachusetts Institute of Technology, and Paul G. Bradley, associate professor of economics at the University of British Columbia. Research is supported by an RFF grant of $9,700 to the Massachusetts Institute of Technology.

Substitution Among Commodities

One solution to problems of inadequacy of specific mineral resources is to use substitutes for the commodity that may be in short supply. A pilot study conducted jointly by Resources for the Future and Oak Ridge National Laboratory has explored this question.

During a three-month stay at Resources for the Future, H. E. Goeller, a chemical design engineer at Oak Ridge, joined Joel Darmstadter of RFF in appraising the outlook for four nonferrous metals — copper, lead, zinc, and tin — with a view of determining the substitutes that could be used for them in various industrial processes, should future shortages require it. At the end of the program year, a report on preliminary findings was being prepared, on the basis of which the feasibility of further research would be considered.

Regional and Urban Studies

Urban growth has confronted both developing and developed nations with a common challenge to public policy — how to control the pattern, rate, and quality of urbanization in order to attain maximum welfare gains. Even in the United States, the richest and most advanced of industrial nations, there has been a growing number of failures in the reliable provision of the overhead services to large urban centers. The "brown-outs" in most major electric power systems around the country; the spectacular decline in the quality of telephone services in New York City in recent months; the severe difficulties of the urban education system; taxpayer revolts; the growth of crime and civil disorder in the cities — all represent breakdowns in existing urban institutions upon which the viability of the large city depends. Many of our most urgent concerns about the degradation of the environment stem ultimately from the scale of the great urban establishments.

Sample surveys suggest that the majority of the residents of large cities would prefer to live "somewhere else." This includes not only the rich and middle-income groups, who do move out, but also the poor who, trapped in the inner city, vent their frustration in explosions of violence or sink into apathy.

While urban America is not typical of the developed world as a whole, it probably does have in common with Western Europe a growing preoccupation with maintaining the viability of its urban system.

In the developing countries the explosive growth of the great cities is generating environmental and servicing problems and is exacerbating the difficulties of achieving satisfactory processes of economic development.

Many countries in the last few years have enunciated comprehensive policies for internal development; even in the United States the present administration has urged the adoption of a "national growth policy" to mitigate the worst effects of our present pattern of urbanization.

Nevertheless, it is not clear how governments can intervene effectively in the social and economic processes responsible for the evolution of the urban pattern. We know that cities grow and change as the result of decisions of people to move from one place to another and of decisions to locate new job-creating investment in certain places as distinguished from others. We know much about the way people and economic activities have become distributed over national landscapes in response to changing demand and production conditions in national markets. But we do not know much about the web of cause and effect which at any moment is altering the urban configurations. Yet such knowledge is essential for the formulation of effective national internal development policies.

During the past year, the staff of the urban and regional studies program has given high priority to research which will help to clarify the processes of urban development and define the policy alternatives available to nations beset by pressing urban problems. We have addressed the specific questions asked below.

SOCIAL CHANGE AND THE URBAN SYSTEM

How can we usefully describe the processes of social change by which urban characteristics evolve in a national economy?

Edgar S. Dunn, Jr., of the RFF staff, completed a manuscript entitled *Economic and Social Development: A Process of Social Learning,* which is now in press. This study was prompted by the limitations Dunn encountered in analyzing the internal development of the United States between 1940 and 1960 in terms of the changes in the industrial structure of employment in 3,104 counties. Concluding that conventional economic growth models do not adequately explain observed urban social change, he proposes a more general model based on the concept of social learning, in which each experience undergone by a social system changes the way in which succeeding experiences are apprehended and responded to by the system. Hence, social change is possible because society "learns" as it goes, and this learning is cumulative — embodied in such social elements as technology, social organization, and institutions as well as in formal education.

What is the most useful model for describing the "behavior" of the urban system in a national economy?

Within the context of the more general study mentioned above, Dunn has turned to the problem of conceptually defining the urban system — a nation's cities and their interrelations. Since the characteristics of the urban system are the target of national internal development policies, this new phase of Dunn's analysis will provide a better understanding of how the urban system grows, changes, and responds to policy measures. Dunn sees the urban system as a hierarchically organized "control system" in which the institutions of control — governmental units, financial agencies, managerial offices — have been inadequately organized, causing conflict and waste in the determination of social goals and the selection of means to achieve them. The urban system is not adapted for being an efficient social learner, and hence its policy responses are not always appropriate to the problem apprehended. Utilizing 1970 census data, Dunn also plans to turn again to the empirical analysis of recent U.S. internal development.

What are the determinants of the distribution of city sizes in an urban system?

Alan W. Evans, lecturer in urban studies, Department of Social and Economic Studies, University of Glasgow, will attempt to develop and test an economic theory of the size of cities under an RFF grant of $9,820 to the university. Very little is known about the factors determining the size of cities and the distribution of city sizes. Evans approaches his project with the proposition that city size is governed by the locational choices of firms seeking to minimize their production costs: City A is larger than City B because no firm now in City A could improve its position by moving to City B. Evans, hence, will be concerned with the economic characteristics distinguishing firms in the two cities. He will use Great Britain as his test case, since it has excellent data on the location of firms generated by the administration of British industrial location policies. If Evans's exploration of the British experience is positive, we would hope for an opportunity to have him address the same question in the U.S. context.

REGIONAL SIZE AND COMPOSITION

What are the determinants of the size, urban composition, and stability of the individual regions in a national economy?

Benjamin Chinitz, professor of economics at Brown University, is studying determinants of geographic patterns of population growth, under an RFF grant of $31,300 to the university. Unlike Evans, Chinitz will treat the urban system in terms of spatially related regional subsystems which can be described in terms of total population; rural, suburban, urban, and metropolitan characteristics; and the manner in which change takes place. Chinitz is concerned with short-run dynamic changes, such as can be described in a census period, and in the identification of causal factors in the U.S. experience between 1950 and 1960.

Chinitz's research is a logical link between an earlier RFF study, *Regions, Resources, and Economic Growth*, and our growing concern with the nature of the national urban systems. He will seek explanation for the disparities in regional growth patterns among rates of inmigration and outmigration, changes in racial composition, shifts in regional industrial structures, and in the characteristics of national economic growth. Chinitz will test his findings for 1950-60 against 1960-70 data expected from the 1970 census. It is hoped that the results of the research will make it much simpler to identify the strategic points for policy intervention in the nation's internal development processes.

SOCIAL COSTS AND OPTIMAL CITY SIZE

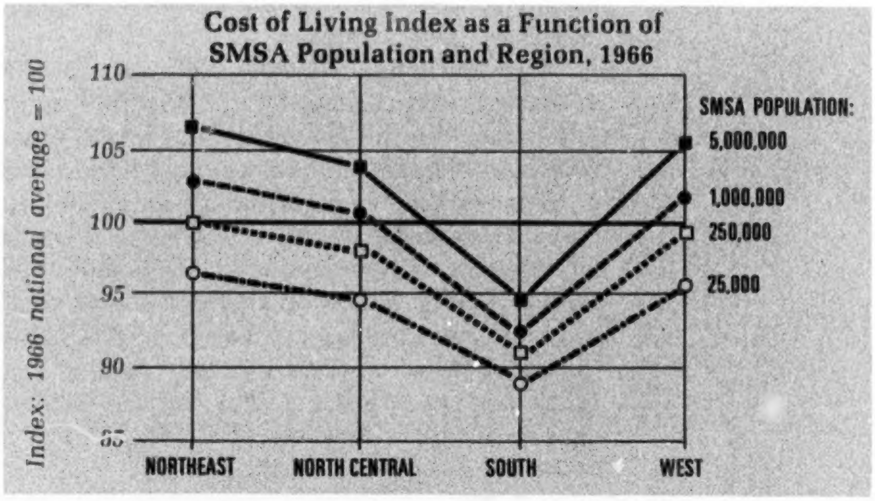
In the absence of public policies to constrain city size, do large cities tend to become too big?

Edwin S. Mills, professor of economics and public affairs at Princeton University, is carrying out research on locational choices and optimal city size under an RFF grant of $33,300 to the university. A large share of the justification of a national urban policy rests on the proposition that the national welfare would be improved if future population growth were directed away from the large metropolitan centers to smaller cities. Cited in support of this belief are the high social costs of environmental degradation, congestion, and public services in the great metropolitan regions; the diversion of a single migrant from New York to, say, Providence would produce a saving in these costs of urban scale. It is further argued that location decisions by firms and individuals are made without calculating the full incremental costs, so that the receiving city implicitly subsidizes its own growth and hence its own loss of productive efficiency.

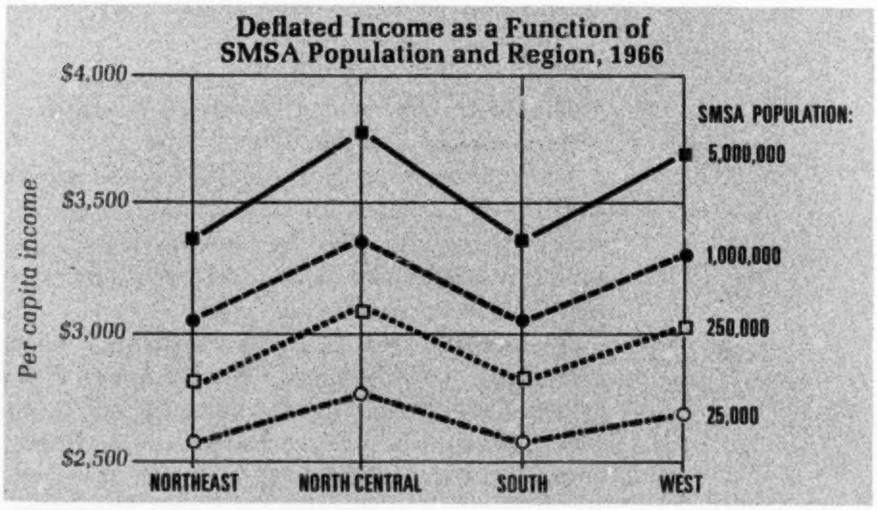
Mills's research begins with the proposition that if firms' actual production costs are lower than the social costs incurred by their product, then cities are too big. This leads him to analyze the efficiency of markets in which urban locational decisions are made, focusing especially on the way in which congestion costs are distributed among "users" of the city. Mills's theoretical analysis will be backed up by an empirical look at the production of urban transportation services and the distribution of their costs and benefits. Finally, Mills will explore the probable effect on city size of distributing congestion costs and other transportation costs among the users causing them. In a recent monograph (see below) Mills has already concluded that rational pricing of urban transportation services would produce a less concentrated, more spread-out kind of urban form. In his present research he will explore how such price policies would affect actual size of cities.

What are the economic trade-offs involving city size, population density, and building characteristics?

Recent research by Irving Hoch at RFF has suggested that the existence of such trade-offs is frequently neglected in discussions of internal development policy. For example, it has been argued that the social costs of large cities with high densities justify whatever subsidies might be necessary to divert future urban growth from such cities to smaller new communities even though



Cost of Living Index as a Function of SMSA Population and Region, 1966



Deflated Income as a Function of SMSA Population and Region, 1966

The upper chart compares the cost of a standard market basket between areas and size of place, relative to the national average for the United States. Thus a person living in a metropolitan area of 5,000,000 in the Northeast would pay $1.06, while a person in an area of 25,000 in the South would pay 88¢ for $1.00 worth of goods priced at the national average. The lower chart compares average incomes between areas and size of place after adjusting for cost of living differences given in the top chart. It can be seen that deflated incomes increase with size. It may well be that this represents additional compensation necessary to attract people to larger areas, though differences in average skill levels may also be involved. Other evidence available indicates the first explanation noted is of considerable importance. The data are obtained from regression equations based on observations on forty-two areas derived from statistics compiled by the Bureau of Labor Statistics (U.S. Department of Labor) and Office of Business Economics (U.S. Department of Commerce).

the latter, with questionable economic logic, are also designed for relatively high densities.

However, it may be that each city has its own optimum size as a result of its industrial composition, its infrastructure, and its relationship with the rest-of-the-world economy. Then, such a diversion might force large cities below — and small cities above — their optimal sizes, resulting in a double loss in national income. Hoch finds evidence that social costs increase rapidly with city size but fail to overweigh the substantially greater productivity of certain kinds of economic activities in such cities. His research and conclusions are discussed in his paper, "Trade-offs Involving City Size, Density, and Building Type," presented to the Workshop on Transportation for New Towns and Communities, organized by the Institute of Public Administration for the Urban Mass Transportation Administration.

THE CITY'S INTERNAL ORGANIZATION

How can changes in the internal organization of the city be described and explained?

Irving Hoch's research described above grows out of a continuing line of research on the economic aspects of the use of urban space, especially the way in which building types as forms of physical capital are related to the organization of population and economic activities in the city.

Toward the end of the year Edwin S. Mills completed a manuscript entitled "Studies in the Structure of the Urban Economy," which summarizes the findings of his research activities under RFF grants over the past two years. Generalizing about major recent developments in the characteristics of the U.S. urban systems, he asserts that (a) the U.S. rate of urbanization is slowing down; (b) metropolitan areas as a whole are becoming less specialized in the economic roles they play in the national economy; and (c) suburbanization of some classes of economic activity, especially retailing and wholesaling, has proceeded more rapidly than the outward movement of population.

Mills's major concern is with "density gradients." He finds generally that employment in major industrial categories has shifted toward the suburbs in recent years. To illuminate these findings, Mills constructs a number of mathematical models. Primary emphasis is placed on a simultaneous equation model of land use and transportation which takes some account of congestion and specifies the location of the edge of the city and the gradients of transportation costs, land rent, and population density. Mills is able to explore, for example, the consequences of directly charging users the costs of expanding the transportation system's capacity. Tests of this model indicate that such a transportation price policy would result in a pronounced decentralization of activities in the urban area accompanied by a precipitous drop in land values the nearer the location is to the center of the city.

MECHANISMS OF SOCIAL CONTROL

How can the mechanisms of social control of the urban system be improved?

In an exploratory effort aimed at improving the governmental processes of cities, we have joined forces with Charles M. Haar of the Harvard Law School in drawing together a group of experts as an unofficial commission on the Governance of Metropolitan Regions. The function of the group is visualized as similar to that of the Royal Commission on Local Government in England, which recently recommended a general reorganization of governmental institutions throughout the country. The basic concept behind it is the need to adopt the organizations of government to the critical problems of the great cities. This means that key roles will be played by members and consultants who are specialists either in urban problems as such or in the organizations that will translate the problem aspects into institutional arrangements.

Members of the group are: Guthrie S. Birkhead, director, Metropolitan Studies Program, Maxwell Graduate School of Citizenship and Public Affairs, Syracuse University; Alan K. Campbell, dean, Maxwell Graduate School of Citizenship and Public Affairs, Syracuse University; Lisle C. Carter, Jr., vice president for social and environmental studies, Cornell University; William G. Colman, private consultant; Edgar S. Dunn, Jr., senior research associate, RFF; Daniel W. Fessler, professor of law, University of California, Davis; Frank Fisher, special assistant to the secretary, Department of Housing and Urban Development; Joseph L. Fisher, president, RFF; Lyle C. Fitch, president, Institute of Public Administration; Bernard J. Frieden, professor, Department of Planning and Urban Studies, Massachusetts Institute of Technology; Edwin T. Haefele, senior research associate, RFF; Mark E. Keane, executive director, International City Management Association; Julius Margolis, director, Fels Institute of State and Local Government, University of Pennsylvania; John R. Meyer, director, National Bureau of Economic Research; William L. C. Wheaton, dean, School of Environmental Design, University of California, Berkeley; and Lowdon Wingo, director, regional and urban studies, RFF.

Haar will prepare a review of the current problems of metropolitan governance and the kinds of institutional changes that would seem to make metropolitan governmental institutions more responsive to the complexity of the problems they face. The group held an organizational meeting on 11 May and began its detailed exploration of the problem on 28 September in a meeting at RFF in Washington.

The British effort to restructure its great conurbations by using green belts and new towns has become highly relevant to the present concern in the United States with national urban development policies. Lowdon Wingo prepared a paper, "New Towns, Overspill, and Metropolitan Deconcentration: Some Lessons from Glasgow," for the Workshop on Transportation and New Communities sponsored by the Urban Mass Transportation Administration.

The experience, problems, and prospects of the economically stagnant West Clydeside (Glasgow) conurbation in Scotland provide a valuable case study of the evolution of a metropolitan development policy, which currently proposes to decant as much as a third of Glasgow's million people into New Towns or existing settlements in the region's hinterlands. The paper identifies two pitfalls in such a strategy: first, severe fragmentation of the region's labor market, which would mortgage the region's economic future to unnecessarily high labor costs and act as a brake on its growth; second, perverse effects on the low-income groups in Glasgow of the relocation procedures, and the effect of the housing subsidies that are the major component of the city's social policy. The outcome would be a substantial increase in economic segregation, and Glasgow could be converted into a dependent welfare enclave in a hinterland which will increasingly preempt the region's opportunities for economic growth.

Similar strategies of decentralization have been proposed. If applied to the older, densely occupied American cities, they could have similar negative consequences, none of which has been given adequate consideration by the proponents of decentralization. What is needed in both cases, Wingo suggests, is a locus in the network of governmental institutions bearing on a region where alternative regional development patterns can be identified and tested for their potential impacts on the welfare of the various regional social and economic groups.

Every major industrialized country is confronted with the problem of what to do about regions that are being bypassed by the benefits of economic growth and change. Gordon Cameron of the University of Glasgow examines federal policy for such cities and other distressed areas in the United States in his study, *Regional Economic Development: The Federal Role,* which is now in press. He began his study as a visiting scholar at RFF and completed it under an RFF grant to the university, where he is senior lecturer in applied economics. Previously, he had participated in the British effort to deal with chronic regional problems. In his analysis of the nature and extent of federal attempts to revitalize distressed areas in the United States he traces the early years of the area development program administered by the Economic Development Administration, and finds that the program's effectiveness was weakened because funds were dispersed too widely at first and then too exclusively to areas of limited potential. These strategies were replaced by a commitment to a more selective "growth center" approach. In Cameron's opinion, this approach destroys the myth that development potential is distributed equally over space, and he sees it as the basis for sound development of U.S. distressed areas. His book should be a useful platform for dealing with the next generation of regional problems and suggests a formula for the evaluation of regional development programs more generally.

URBANIZATION IN DEVELOPING COUNTRIES

How can our findings about the processes of urbanization be related to the special circumstances of the developing countries?

The International Bank for Reconstruction and Development estimates that between 1960 and 2000 urban population in developing countries will increase four and a half times and will only double in the industrialized countries. Projections such as these have spurred the major international agencies, such as the World Bank, the United Nations, and the Organization of American States, to equip themselves to help developing countries anticipate the problems that accompany rapid urbanization. RFF's long interest in the regional and urban problems of developing countries has led to a joint research effort with the Economics of Urbanization Division of the World Bank addressed to some of the key questions encountered by developing countries in formulating and coordinating policies for rationalizing their urban development.

On the RFF side, Lowdon Wingo is continuing his analysis of the determinants of investments in urban public facilities, using Chilean and Venezuelan case materials, while Pierre Crosson is initiating research on the impact of agricultural development on urbanization, relying heavily on recent Mexican experience. (See also RFF's Latin American program, page 89.) Members of the Bank's research staff have completed a survey of the overall problem, have examined appropriate transportation development strategies for metropolitan areas in developing countries, and are finishing research on the cost of urban services in Pakistan.

A slate of critical reviews of the state of knowledge in several policy areas will be undertaken, not only to update the knowledge of key professionals in international agencies and inform scholars about the intellectual content of these areas but also to identify key research priorities for future phases of the program. In addition, a continuing joint research seminar on the economics of urbanization is being launched.

A joint information and documentation system is being developed to bring together fugitive and hard-to-obtain materials from developing countries, as well as important journal articles and other published materials. The objective is to expedite access to these materials by researchers involved in the joint program.

Finally, research missions will be undertaken by individual scholars or research teams to carry out special research activities to supplement the overall effort. During the past year, in the interests of the joint research effort, the Bank sponsored two economic missions, one to Brazil and another to Venezuela, in which Lowdon Wingo participated. Both missions produced reports on critical urban and regional development problems in those countries.

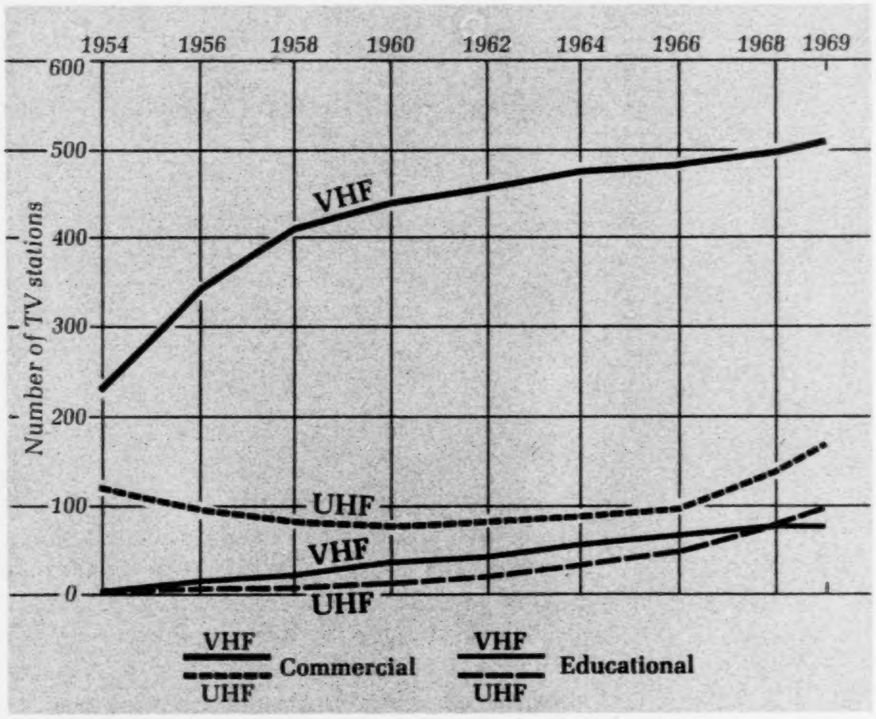
Appraisals and Special Projects

Several projects conducted or sponsored by Resources for the Future are administered separately from the major categories of research dealt with elsewhere in this report. Some are an outgrowth of the appraisal of resource adequacy in the United States published in 1963 as *Resources in America's Future.* They deal with situations where sufficiency of resource supply may be in question or where technology has opened up new possibilities in the use of a resource. Other projects deal with marine resources, and a few are extensions of RFF's educational function — an integral part of each of its research programs.

RESOURCE APPRAISALS

The Radio Spectrum

During the year an analysis of the utilization of the radio spectrum by Harvey J. Levin, professor of economics at Hofstra University, was brought to conclusion and is in press. The project was begun in 1964 when the radio spectrum was a concept familiar only to technical experts and a few government regulators. In the intervening years interest has broadened. Crowded communication channels, questions of policy regarding the most efficient and equitable allocation of this increasingly scarce resource, issues connected with the public interest in the subject matter transmitted over the air, and other aspects of the radio spectrum have become increasingly important and controversial. All this led to the appointment of a Presidential Task Force that reported its findings late in 1968, but since then new facets — such as the rapid spread of cable television (CATV), the concept of the "wired city," and renewed attention to use of communication satellites — have further kept the debate a lively one. Levin's study provides the background for students of this rapidly expanding area. An article drawing on his research appeared in the May 1970 *American Economic Review.* The book will be published under the title *The Invisible Resource — Use and Regulation of the Radio Spectrum.*



Over the last five years ultra high frequency TV stations in the United States have doubled among commercial stations and tripled among educational stations. The chart is based on data presented in RFF's forthcoming book, The Invisible Resource.

Changing Technology in Iron and Steel

An investigation of technological change in the U.S. steel industry was completed during the year. Bela Gold, G. Rosegger, and W. Peirce, professors in the Department of Economics at Case Western Reserve University, are revising the first draft of a manuscript resulting from their study. Some of their findings appeared in an article, "Diffusion of Innovation in the U.S. Iron and Steel Industry," published in the July 1970 issue of the *Journal of Industrial Economics*; and the analytical framework used in the study was described in a paper, "Productivity and Technology," given at the Seventeenth International Conference of the Institute of Management Sciences, held in London in July.

The Sulphur Industry

Published during the program year was a study, *The Economics of the Sulphur Industry*, which analyzes the performance of that portion of the U.S. sulphur industry that uses the Frasch process and has dominated world production for the last half-century. The author, Jared E. Hazleton, is professor in the Department of Economics, University of Texas.

Marine Resources

In seeking solutions to increasingly complex problems in the management and administration of internationally shared marine resources, it is important to know more about what lies behind these problems and about past experiences in management. Two current RFF-supported studies are designed to provide background information on the two major areas of marine resource development: the continental shelf and seabed, and the high seas fisheries.

L. F. E. Goldie, Charles Stockton professor of international law at the Naval War College, has been working for several years on a detailed study of the legal problems of the continental shelf and of the resources of the seabed and subsoil beyond the shelf. As a result of his work thus far, he has published a number of articles in professional journals, the most recent being: "Where Is the Continental Shelf's Outer Boundary?," *Journal of Maritime Law and Commerce* (April 1970); and "The Oceans' Resources and International Law — Possible Developments in Regional Fisheries Management," *Columbia Journal of Transnational Law* (Spring 1969). "Sedentary Fisheries and the North Sea Continental Shelf Cases — A Paradox Revealed," appeared in the comments section, *American Journal of International Law* (July 1969).

During the year a grant of $36,700 was made to the University of Washington, where William T. Burke of the School of Law is undertaking a study of regulatory systems for international fisheries. Some of these systems have been in existence for several decades and their operations have been of importance in international management and decision making, but so far they have received scant attention from social scientists.

Burke will examine several international fishery commissions and agreements to determine how decisions are made, how successful the commissions are in reaching their stated goals, the relevance of the goals to the problems, the effect of the decisions on management problems, and ways in which the arrangements might be improved. His analysis of international cooperation and of impediments to cooperation on fishery problems should benefit international arrangements on other uses and resources of the sea.

Monographs on Hydrology and Water Resources

A grant of $7,000 was made to the American Geophysical Union for the initiation of a continuing series of monographs on hydrology and water resources. There is often a substantial time lag between the reporting of important analytical methods or hydrologic procedures and their application. This may be the result of the rapid advance of research, the profusion of professional writings, or the inability of many practicing hydrologists — often working in remote locations — to consider and evaluate all of the research findings available to them. The monograph series will be an attempt to shorten this time lag. Although the series will not contribute directly to RFF research, it will be a useful "extension" activity that should facilitate the adoption of the results of RFF studies, as well as the results of other studies, into hydrologic practices and water resource management.

The Energy Economy of East Europe

A study of the production, trade, and consumption of energy resources in East European countries was prepared by Jay G. Polach, a former staff member. It was undertaken at the request of the Subcommittee on Foreign Economic Policy of the Joint Economic Committee of the Congress, and published in a Joint Committee Print entitled *Economic Developments in Countries of Eastern Europe.*

Population Studies

The impact of population growth, size, and distribution on environmental quality and natural resources must be better understood before effective national policies and programs can be developed to cope with environmental problems. Ronald Ridker, who joined the RFF staff in September, will attempt to add to the store of information in this area by studying the effects of demographic trends on the natural environment. Formerly with the Agency for International Development, Ridker worked on policy problems related to population programs, employment, and economic planning in developing countries. Previously, he undertook one of the first comprehensive studies of the economic costs of air pollution damage while associated with the Brookings Institution. At RFF, Ridker will explore the interrelationships between the natural environment, population growth, and economic development. Some of his work will be done in cooperation with the Commission on Population Growth and the American Future and with the Population Council as a preliminary to the possible establishment of a joint program in demographic-environmental studies.

RFF Fellowship Program

During 1969-70, the tenth year in which RFF has conducted its resources fellowship program, twelve fellowships were awarded to doctoral candidates whose dissertations will involve the application of the social sciences to natural resource problems:

Dennis Capozza, Johns Hopkins University — The impact of an urban transportation improvement

Proinnsias S. Convery, Syracuse University — A land-use model for allocating marginal rural land in Ireland

Richard V. Eastin, University of California, Santa Barbara — The implications of the interaction of transportation, pollution, and the location of economic units for land-use planning

Orville F. Grimes, University of Chicago — Monetary evaluation of recreation and aesthetic uses of water in an urban setting

Dae K. Kahng, University of Oklahoma — An analysis of the technical diffusion processes in the steam-electric generating industry in the U.S., with special emphasis on the role of fuel inputs (coal, oil, and natural gas): an econometric model

Mark C. Kendall, University of Rochester — Externalities and the fishing industry

Clifford R. Kern, Harvard University — Adjustments in the quality of the housing stock

Alexander L. Morton, Harvard University — The demand for intercity freight transportation

David E. Pingry, Purdue University — An economic decision-making model for selecting a pollution abatement program in a river basin

Mohammad A. Qadeer, Columbia University — A proposal for the study of externalities of a new town: the impact of Columbia, Maryland, on the surrounding region

Rowan A. Rowntree, University of California, Berkeley — Man's influence on succession and diversity in estuarine environment: Bolinas Lagoon, California

Stephen H. Zeller, Boston College — Property taxation and urban land allocation

Five RFF Fellows of previous years presented dissertations to their universities in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The theses are listed below:

Bryan C. Ellickson, Massachusetts Institute of Technology — Metropolitan residential location and the local public sector

Roger W. Pearson, University of Illinois — Resource management strategies and regional viability: a study of the Great Slave Lake region, Canada

Paul D. Qualls, University of California, Berkeley — The Russian River Project: a case study in the economics of water resources development

Norman P. Swenson, Washington University — An economic analysis of federal timber marketing policies in southeast Alaska

T. Nicholas Tideman, University of Chicago — Three approaches to improving urban land use

Latin American Program

The year has seen an expansion in RFF work concerning the role of resources in the economic development of Latin American countries. Some of the research has been mounted from the United States, and some from Latin America where we can more readily discern new dimensions of the subject, make use of local sources, and collaborate with host country scholars and administrators. One of the aims has been to help develop the field of resource analysis by working closely with local scholars and students and by teaching courses or seminars where the opportunity is presented. That aim has been advanced during the year through operations in three countries — Mexico, Argentina, and Chile.

WORK IN MEXICO

In Mexico RFF's representative, Ronald Cummings, offered a graduate seminar in resource economics at the Postgraduate College of the National Agricultural School in Chapingo, gave another graduate seminar on water planning in the engineering school of the National University (UNAM) during the spring semester, and lectured on resource problems to the economics staff of the Bank of Mexico. He also gave courses in mathematics and economics for staff members at the Mexican Ministry of Water Resources (SRH) and prepared a paper for the world symposium on arid lands held in Mexico City in November. In the course of this work he has supervised the thesis research of several Mexican students from Chapingo and UNAM whose studies are related to resource economics. The collaboration with SRH has been especially useful. It has permitted Cummings to look at planning problems in a full operational setting, and this has enabled him to assist Mexican colleagues with suggestions on methodology in the area of his own competence. Stemming from this latter phase of our work in Latin America, RFF sponsored a week-long series of lectures in Mexico City on dynamic programming. The lectures, given by

Oscar Burt, professor of agricultural economics at Montana State University, were attended by Mexican scholars and by senior planners and administrators from various resource agencies.

Cummings's research during the year has been concentrated in the field of Mexican water economics. An article, "Water Resource Management in Arid Environs," in which Donald Winkelman of Iowa State University collaborated, appears in the October 1970 issue of *Water Resources Research*. Cummings has lately finished a study of water resource management in the arid environs of northern Mexico. This deals with some of the problems of optimizing agricultural water use in a situation where water supply is scarce and erratic, where storage capacity and irrigable land are ample, and where low farm income makes income stability an essential policy aim. Future research will continue to be directed to problems of planning and managing Mexican water resources.

WORK IN ARGENTINA

In Argentina RFF's representative, Delbert Fitchett, has continued to collaborate with the Di Tella Institute. Teaching opportunities have been less numerous than in Mexico, but during the year Fitchett conducted a course in resource economics at the Catholic University in Buenos Aires, and Cummings visited Argentina late in the year to lecture before university and government groups on programming and water planning.

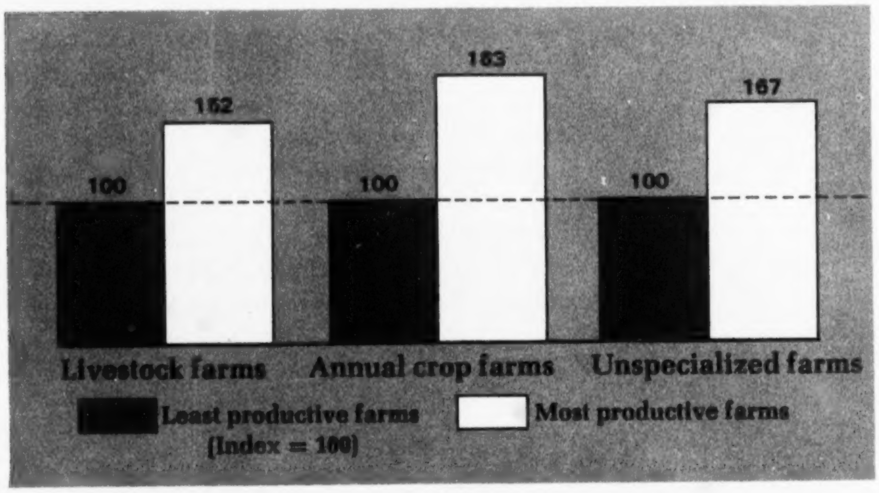
The research focus in Argentina has been on prospects for development in the area of northern Patagonia. Following a review of past trends in the area, a series of projects has been undertaken to examine growth prospects in sectors of the regional economy. These studies are being made by Fitchett, by members of the Di Tella staff, and by others brought into the project by Resources for the Future.

WORK WITH ILPES IN CHILE

In Chile RFF's presence is of longer standing than elsewhere in Latin America and is of a somewhat different character. Work there has been primarily a research operation in collaboration with the Latin American Institute for Economic and Social Planning (ILPES). RFF's representative in Chile, Michael Nelson, has completed an extensive study of tropical colonization schemes in several Latin American countries, and is now revising his manuscript. The projects studied range from ones that have enjoyed complete government support — with housing, infrastructure, training, and other services all provided — to spontaneous settlements where the government's contribution was little more than an access road. On the whole, Nelson concludes that tropical colonization remains a very difficult venture that holds scant promise as an economically rational solution to the demographic and social problems of settled areas. If new settlement is to succeed, it must have special conditions of market access or be part of a larger development extending beyond agriculture.

Nelson is undertaking further research, a case study based on Bolivia, to compare the advantages of tropical colonization with those of more intensive development of existing centers such as the Bolivian altiplano. Much of the interest in colonization is motivated by a desire to relieve population pressure on the land and thereby the depression of rural income in settled areas. However, if other resources are applied to land, its productivity conceivably may be raised enough to accommodate both a growth in the rural population and rising incomes. This question of development strategy was approached only from the side of the success of colonization projects in his earlier study. In the Bolivian case, Nelson is confronting both of the alternatives.

In the course of the year Nelson lectured at the Urban Studies Center of the University of Chile. He also served on ILPES-



Pierre Crosson's analysis of farm productivity in Chile shows that factors other than land and labor are the chief determinants of agricultural performance. The chart above shows relative differences in total productivity between groups of most and least productive farms in each of three categories. The comparison is between the top and bottom halves of the farms in each category. Although many factors influenced the differences in productivity, Crosson concluded that the most important was the ability of the most productive farmers to employ considerably more farm machinery, fertilizer, and pesticides per unit of land and labor than the least productive farms.

sponsored advisory missions dealing with agricultural planning problems in Bolivia and Venezuela, and on a similar type of mission in Panama sponsored by U.S. AID.

Other work has grown out of our six-year collaboration with ILPES. Studies by Nathaniel Wollman (*The Water Resources of Chile*) and by Orris C. Herfindahl (*Natural Resource Information for Economic Development*) were published earlier under joint ILPES-RFF sponsorship. A condensed version of the Wollman book was issued by ILPES as "Los Recursos Hidraulicos de Chile" in their *Cuaderno* series; a translation of Herfindahl's book is in process of publication by ILPES.

Lowdon Wingo spent some weeks in Venezuela in connection with his study on the use of urban infrastructure investment as a means of shaping the pattern and speed of urban growth. The study, which was initiated several years ago when he worked with ILPES in Chile, is now being expanded to include the results of his recent research in Venezuela.

Another project growing out of our collaboration with ILPES is Pierre Crosson's study of agricultural productivity in Chile. Drawing on data from a sample of Chilean farms and from historical information on Chilean agricultural trends and policies, Crosson analyzed some of the factors that have affected agricultural performance. Not surprisingly, the use of such modern inputs as fertilizers, pesticides, and machinery is shown to be associated with more productive use of resources. A major conclusion is that limitations on the supply of modern inputs imposed by credit and import policies were a major cause of the relatively poor performance of Chilean agriculture in the 1950s, the period covered by the study. The study, titled *Agricultural Development and Productivity: Lessons from the Chilean Experience*, was in press at the end of the program year.

OTHER WORK IN LATIN AMERICA

Crosson is now turning to a study of factors that influence the rural-urban distribution of population in Mexico. This is a country that has experienced rapid agricultural growth on both commercial and *ejidal* (cooperative) holdings. Nonetheless, much of the countryside remains desperately poor, and the country people continue to stream into the cities where the shortage of housing, services, and employment promises them a meager existence. The reasons for the shift to the cities, and the means of directing or coping with it, are matters of concern to all developing countries and aid agencies. RFF is collaborating in this case with the International Bank for Reconstruction and Development, which also shared in RFF's work undertaken by Wingo in Venezuela.

Two other studies long in preparation came to fruition during the year. The first, *Natural Resources in Latin American Develop-*

ment, by Joseph Grunwald and Philip Musgrove, published in August, is an appraisal of resource-based internationally traded commodities produced in Latin America. The volume presents statistical data on the resource base, consumption, and production of fuels, minerals, and agricultural products over recent decades, reviews the history of resource development, and analyzes future market prospects. *Foreign Investment in the Petroleum and Mineral Industries* by Raymond Mikesell and associates, is scheduled for publication in December. Built around the case studies of investment in extractive industries in several Latin American and Middle Eastern countries, the book traces the origins and resolution of conflict and in some cases the impact of the investment on the host country. (See also page 67.)

In December 1969 RFF sponsored a meeting of Latin American administrators and researchers concerned with resource planning, to discuss the general problem of investing in resource information. The meeting, which was held in Peru, was an outgrowth of Herfindahl's published study. Papers presented at the conference are to be issued in Spanish.

Publications

Much of the research done by Resources for the Future takes final shape in the form of books, journal articles, and reprints meant to appeal to a readership concerned with natural resources, including academic specialists, general students, citizens' groups, and administrators in business, industry, and government.

BOOKS. During the 1969-70 program year, five new books were published and fifteen others were sent to press; the twenty new titles are indicated by an asterisk in the full list of publications which appears below.

Book-length studies are published in two categories: (1) hardcover books for individual and library use, some of which are also made available as low-priced paperbacks for use as texts or supplementary readings in colleges and universities; and (2) paperbound monographs on more specialized research, reconnaisance studies, and collections of papers presented at conferences sponsored by RFF. Most of the books in the first category are published and distributed for Resources for the Future by The Johns Hopkins Press and are indicated in the list below as JHP; the few exceptions issued through other publishers are identified. Books in the second category, which are published by Resources for the Future, are distributed by The Johns Hopkins Press. They are identified in the list as RFF.

GRANT-SUPPORTED STUDIES published by other institutions. Books based on research supported or partially supported by RFF grants and issued by other publishers during the last five years are listed on pages 96-97.

THE RFF REPRINT SERIES. This series makes available in limited quantities reprints of selected papers written by RFF staff members and originally published in journals or proceedings. Single copies are free on request. Nine new reprints were added during the program year. Reprints available at the close of the year and staff writings published in professional journals during the year are listed on pages 97-98.

RESOURCES. This bulletin, issued three times a year, contains brief articles based on material from recent books or papers based on staff research. The January issue reviews some significant events of the previous year relating to the use and management of natural resources. The bulletin, which varies in length from four to sixteen pages, is free on request.

BOOKLETS. The following are available free: a brief description of the organization, *Resources for the Future, Inc.: Its Aims and Work;* a booklet listing RFF fellowship recipients from 1960 to 1967, together with their past and current affiliations; and a list of RFF books in print. Also available is a report on the work of the Committee on Urban Economics and of development in the field from 1959 to 1968, entitled *Progress in Urban Economics.* Single copies of this 142-page publication are available free; additional copies are $1.00 each.

RFF BOOKS

NATURAL RESOURCES AND ECONOMIC DEVELOPMENT

*Arrow, Kenneth J., and Mordecai Kurz. *Public Investment, the Rate of Return, and Optimal Fiscal Policy.* JHP, 1970. 288 pp. $9.00.

Barnett, Harold J., and Chandler Morse. *Scarcity and Growth: The Economics of Natural Resource Availability.* JHP, 1963; second printing 1968. 304 pp. $9.00. Paper 1969, $2.25. Polish edition. *Ekonomika zasobow naturalnych.* Warsaw: Ksiaka i Wiedza, 1967. Zl 30.

Clawson, Marion, ed. *Natural Resources and International Development* — essays based on the RFF Forum lectures of 1963. JHP, 1964; second printing 1965. 474 pp. $10.00.

Fisher, Joseph L., and Neal Potter. *World Prospects for Natural Resources: Some Projections of Demand and Indicators of Supply to the Year 2000.* RFF, 1964; second printing 1965. 78 pp. Paper, $1.50.

Haveman, Robert H., and John V. Krutilla. *Unemployment, Idle Capacity, and the Evaluation of Public Expenditures: National and Regional Analyses.* JHP, 1968. 160 pp. $6.50.

Jarrett, Henry, ed. *Comparisons in Resource Management: Six Notable Programs in Other Countries and Their Possible U.S. Application* — essays based on the RFF Forum lectures of 1961. JHP, 1961. 288 pp. $6.50. Paper edition (University of Nebraska Press) 1965. $1.65.

Landsberg, Hans H. *Natural Resources for U.S. Growth: A Look Ahead to the Year 2000.* For general readers, based on *Resources in America's Future.* JHP, 1964; third printing 1967. 256 pp. Paper, $2.45.

Landsberg, Hans H., Leonard L. Fischman, and Joseph L. Fisher. *Resources in America's Future: Patterns of Requirements and Availabilities, 1960-2000.* JHP, 1963; second printing 1964. 1,040 pp. $15.00. Russian edition. *Resursy S.Sh.A. v budushtshem.* 2 vols. Moscow: Isdatelstvo Progress, 1965, 3r. 57k.

*Levin, Harvey J. *The Invisible Resource: Use and Regulation of the Radio Spectrum.* JHP. Publication scheduled for Spring 1971.

Potter, Neal, and Francis T. Christy, Jr. *Trends in Natural Resource Commodities: Statistics of Prices, Output, Consumption, Foreign Trade, and Employment in the United States, 1870-1959.* JHP, 1962. 580 pp. $17.50.

ENVIRONMENTAL STUDIES

*Goldstein, Jon H. *Competition for Wetlands in the Midwest: An Economic Analysis.* RFF. Publication scheduled for Spring 1971. Paper.

Headley, J. C., and J. N. Lewis. *The Pesticide Problem: An Economic Approach to Public Policy.* RFF, 1967. 160 pp. Paper, $3.50.

Herfindahl, Orris C., and Allen V. Kneese.

***Published or in press during the 1969-70 program year.**

***Note:* RFF and JHP books in this list may be ordered from The Johns Hopkins Press, Baltimore, Maryland 21218, or 2-4 Brook Street, London W. 1A, 1AA, England.**

Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water, and Air. RFF, 1965; third printing 1969. 104 pp. Paper, $2.00.

Jarrett, Henry, ed. *Environmental Quality in a Growing Economy*—essays based on the RFF Forum lectures of 1966. JHP, 1966; second printing 1968. 188 pp. $5.00.

Jarrett, Henry, ed. *Perspectives on Conservation*—essays on America's natural resources based on the RFF Forum lectures of 1958. JHP, 1958; fourth printing 1968. 272 pp. $6.50. Paper, 1969, $2.45.

*Kneese, Allen V., Robert U. Ayres, and Ralph C. d'Arge. *Economics and the Environment: A Materials Balance Approach.* RFF, December 1970. 160 pp. Paper, $2.50.

WATER RESOURCES

Bain, Joe S., Richard E. Caves, and Julius Margolis. *Northern California's Water Industry: The Comparative Efficiency of Public Enterprise in Developing a Scarce Natural Resource.* JHP, 1966. 784 pp. $17.50.

Cleary, Edward J. *The ORSANCO Story: Water Quality Management in the Ohio Valley under an Interstate Compact.* JHP, 1967. 352 pp. $10.00. Paper, $2.95.

Cootner, Paul H., and George O. G. Löf. *Water Demand for Steam Electric Generation: An Economic Projection Model.* RFF, 1966. 156 pp. Paper, $4.00.

Craine, Lyle E. *Water Management Innovations in England.* RFF, 1969. 130 pp. Paper, $3.50.

Davis, Robert K. *The Range of Choice in Water Management: A Study of Dissolved Oxygen in the Potomac Estuary.* JHP, 1968. 204 pp. $7.00.

*Hartman, L. M., and Don Seastone. *Water Transfers: Economic Efficiency and Alternative Institutions.* JHP, 1970. 144 pp. $5.75.

Howe, Charles W., et al. *Inland Waterway Transportation: Studies in Public and Private Management and Investment Decisions.* RFF, 1969. 144 pp. Paper, $5.00.

*Howe, Charles W., and K. William Easter. *Interbasin Transfers of Water: Economic Issues and Impacts.* JHP. Publication scheduled for Spring 1971.

Kneese, Allen V. *Economie et gestion de la qualité des eaux.* Adapted and translated by H. Levy-Lambert. Paris: Dunod, 1967. 37 Fr. (American edition is out of print.)

Kneese, Allen V. *Water Pollution: Economic Aspects and Research Needs.* RFF, 1962; fourth printing 1970. 116 pp. Paper, $1.75.

Kneese, Allen V., and Blair T. Bower. *Managing Water Quality: Economics, Technology, Institutions.* JHP, 1968. 338 pp. $8.95.

Kneese, Allen V., and Stephen C. Smith, eds. *Water Research*—1965 seminars in water resources research (RFF and Western Resources Conference). JHP, 1966; second printing 1969. 534 pp. $15.00.

Krutilla, John V. *The Columbia River Treaty: The Economics of an International River Basin Development.* JHP, 1967. 226 pp. $7.50.

Krutilla, John V., and Otto Eckstein. *Multiple Purpose River Development: Studies in Applied Economic Analysis.* JHP, 1958; third printing 1964. 316 pp. $8.50. Paper 1969, $2.95.

Löf, George O. G., and Allen V. Kneese. *The Economics of Water Utilization in the Beet Sugar Industry.* RFF, 1968. 134 pp. Paper, $4.00.

*Russell, Clifford S., David G. Arey, and Robert W. Kates. *Drought and Water Supply: Implications of the Massachusetts Experience for Municipal Planning.* JHP. December 1970. 248 pp. $8.00.

Ruttan, Vernon W. *The Economic Demand for Irrigated Acreage: New Methodology and Some Preliminary Projections, 1954-1980.* JHP, 1965. 154 pp. $5.00.

*Wollman, Nathaniel, and Gilbert W. Bonem. *The Outlook for Water: Quality, Quantity, and National Growth.* JHP. Publication scheduled for Spring 1971.

MARINE RESOURCES

Christy, Francis T., Jr., and Anthony Scott. *The Common Wealth in Ocean Fisheries: Some Problems of Growth and Economic Allocation.* JHP, 1966. 296 pp. $8.00. Spanish edition. *La pesca oceánica: explotación de una riqueza común, algunos problemas de crecimiento y distribución económica.* México, D.F.: Unión Tipográfica Editorial Hispano Americana, 1967.

Crutchfield, James A., and Giulio Pontecorvo. *The Pacific Salmon Fisheries: A Study of Irrational Conservation.* JHP, 1969. 240 pp. $6.00.

LAND (INCLUDING FORESTRY AND RECREATION)

Clawson, Marion. *The Federal Lands Since 1956: Recent Trends in Use and Management.* RFF, 1967. 128 pp. Paper, $4.00.

Clawson, Marion. *Policy Directions for U.S. Agriculture: Long-Range Choices in Farming and Rural Living.* JHP, 1968. 416 pp. $10.00. Spanish edition. *Problemas de la Producción*

Agrícola. México, D.F.: Editorial Letras, S.A., 1970.

*Clawson, Marion. *Suburban Land Conversion in the United States: An Economic and Governmental Process*. JHP. Publication scheduled for Spring 1971.

Clawson, Marion, and R. Burnell Held. *The Federal Lands: Their Use and Management*. JHP, 1957. 536 pp. $12.50. Second printing 1967. Paper edition (University of Nebraska Press), 1965. $2.95.

Clawson, Marion, R. Burnell Held, and Charles H. Stoddard. *Land for the Future*. JHP, 1960; third printing 1968. 590 pp. $14.00.

Clawson, Marion, and Jack L. Knetsch. *Economics of Outdoor Recreation*. JHP, 1966; second printing, 1969. 348 pp. $8.50.

*Clawson, Marion, Hans H. Landsberg, and Lyle T. Alexander. *The Agricultural Potential of the Middle East*. An RFF-Rand study. (American Elsevier Publishing Company, New York.) In press.

Clawson, Marion, with Charles L. Stewart. *Land Use Information: A Critical Survey of U.S. Statistics, Including Possibilities for Greater Uniformity*. RFF, 1966; second printing, 1969. 420 pp. Paper, $6.00.

Guthrie, John A., and George R. Armstrong. *Western Forest Industry: An Economic Outlook*. JHP, 1961. 352 pp. $9.00.

Held, R. Burnell, and Marion Clawson. *Soil Conservation in Perspective*. JHP, 1965. 360 pp. $9.00. Portuguese edition. *Conservação do Solo: Passado, Presente e Futuro*. Rio de Janeiro: Edições O Cruzeiro, 1965.

Ise, John. *Our National Park Policy: A Critical History*. JHP, 1961. Second printing 1967. 714 pp. $17.50.

Kaufman, Herbert. *The Forest Ranger: A Study in Administrative Behavior*. JHP, 1960; third printing 1967. 278 pp. $6.50. Paper 1967, $2.45.

Morgan, Robert J. *Governing Soil Conservation: Thirty Years of the New Decentralization*. JHP, 1966. 416 pp. $10.00.

Resources for the Future. *Forest Credit in the United States—Report of a Committee appointed by Resources for the Future*. RFF, 1958. 168 pp. Paper, $2.00.

Schmid, A. Allan. *Converting Land from Rural to Urban Uses*. RFF, 1968. 116 pp. Paper, $4.00.

Zivnuska, John A. *U.S. Timber Resources in a World Economy*. RFF, 1967. 140 pp. Paper, $3.50.

ENERGY AND NONFUEL MINERALS

Brooks, David B. *Low-Grade and Nonconventional Sources of Manganese*. RFF, 1966. 136 pp. Paper, $3.00.

Brooks, David B. *Supply and Competition in Minor Metals*. RFF, 1966. 162 pp. Paper, $3.00.

Brooks, David B., and John V. Krutilla. *Peaceful Use of Nuclear Explosives: Some Economic Aspects*. RFF, 1969. 56 pp. Paper, $1.50.

Brubaker, Sterling. *Trends in the World Aluminum Industry*. JHP, 1967. 276 pp. $6.95.

Campbell, Robert W. *The Economics of Soviet Oil and Gas*. JHP, 1968. 294 pp. $8.50.

*Hazleton, Jared E. *The Economics of the Sulphur Industry*. RFF, 1970. 184 pp. Paper, $3.50.

Herfindahl, Orris C. *Copper Costs and Prices: 1870-1957*. JHP, 1959. 272 pp. $7.50.

Landsberg, Hans H., and Sam H. Schurr. *Energy in the United States: Sources, Uses and Policy Issues*. For general readers. New York: Random House, 1968. 240 pp. $5.95. Paper, $2.95.

Lovejoy, Wallace F., and Paul T. Homan. *Economic Aspects of Oil Conservation Regulation*. JHP, 1967. 308 pp. $8.50.

Lovejoy, Wallace F., and Paul T. Homan. *Methods of Estimating Reserves of Crude Oil, Natural Gas, and Natural Gas Liquids*. RFF, 1965. 180 pp. Paper, $3.00.

McDivitt, James F. *Minerals and Men: An Exploration of the World of Minerals and Its Effect on the World We Live In*. For general readers. JHP, 1965. Second printing 1966. 168 pp. Paper, $1.95. Spanish edition. *Los minerales y el hombre*. Mexico: Editorial Limusa-Wiley, S.A., 1966.

*McDonald, Stephen L. *Petroleum Conservation in the United States: An Economic Analysis*. JHP. Publication scheduled for Spring 1971.

*Manners, Gerald. *The Changing World Market for Iron Ore, 1950-1980: An Economic Geography*. JHP. Publication scheduled for Spring 1971.

*Mikesell, Raymond F., and associates. *Foreign Investment in the Petroleum and Mineral Industries: Case Studies of Investor-Host Country Relations*. JHP, December 1970. 460 pp. $15.00.

Netschert, Bruce C., and Sam H. Schurr. *Atomic Energy Applications with Reference to Underdeveloped Countries*. JHP, 1957; second printing 1959. 144 pp. Paper, $2.00.

Resources for the Future. *U.S. Energy Policies: An Agenda for Research*. RFF, 1968; second printing 1969. 164 pp. Paper, $4.00.

Schurr, Sam H. *Historical Statistics of Minerals in the United States*. RFF, 1960; second printing 1966. 48 pp. Paper, $1.00.

*Schurr, Sam H., Paul T. Homan, and associates. *Middle Eastern Oil and the Western*

World: Prospects and Problems. An RFF-Rand Study. (American Elsevier Publishing Company, New York.) In press.

Schurr, Sam H., and Bruce C. Netschert, with Vera F. Eliasberg, Joseph Lerner, and Hans H. Landsberg. *Energy in the American Economy 1850-1975.* JHP, 1960. 796 pp. $15.00. Russian edition. *Energetika ekonomike S.Sh.A. 1850-1975.* Moscow: Isdatelstvo ekonomicheskoe literatury, 1963. 1r. 90k.

URBAN AND REGIONAL STUDIES

*Cameron, Gordon C. *Regional Economic Development: The Federal Role.* RFF, December 1970. 192 pp. Paper, $4.00.

*Dunn, Edgar S., Jr. *Economic and Social Development: A Process of Social Learning.* JHP, December 1970. 314 pp. $10.00.

Heller, Walter W., Richard Ruggles, Lyle C. Fitch, Carl S. Shoup, Harvey E. Brazer. (Harvey S. Perloff and Richard P. Nathan, eds.) *Revenue Sharing and the City.* JHP, 1968. 124 pp. $6.00. Paper, $2.50.

Hirsch, Werner Z., ed. *Elements of Regional Accounts*—papers presented at the Conference on Regional Accounts, 1962, sponsored by the Committee on Regional Accounts. JHP, 1964. 240 pp. $7.50.

Hirsch, Werner Z., ed. *Regional Accounts for Policy Decisions*—papers presented at the Conference on Regional Accounts, 1964, sponsored by the Committee on Regional Accounts. JHP, 1966. 244 pp. $7.50.

Hochwald, Werner, ed. *Design of Regional Accounts*—papers presented at the Conference on Regional Accounts, 1960, sponsored by the Committee on Regional Accounts. JHP, 1961; second printing 1969. 302 pp. $7.50.

Keyes, Scott. *Urban and Regional Studies at U.S. Universities.* Compiled and edited by Scott Keyes under the sponsorship of the Bureau of Community Planning. University of Illinois. RFF, 1964. 136 pp. Paper, $2.00.

Margolis, Julius, ed. *The Public Economy of Urban Communities*—papers presented at a 1964 conference sponsored by the Committee on Urban Economics. RFF, 1965; second printing 1969. 282 pp. Paper, $5.00.

Neutze, Max. *The Suburban Apartment Boom: Case Study of a Land Use Problem.* RFF, 1968. 182 pp. Paper, $5.00.

Perlman, Mark, ed. *Human Resources in the Urban Economy*—papers presented at a 1962 conference sponsored by the Committee on Urban Economics. RFF, 1963; second printing 1964. 278 pp. Paper, $4.50.

Perloff, Harvey S., ed. *The Quality of the Urban Environment: Essays on "New Resources" in an Urban Age.* RFF, 1969; second printing 1970. 344 pp. Paper, $6.50.

Perloff, Harvey S., Edgar S. Dunn, Jr., Eric E. Lampard, and Richard F. Muth. *Regions, Resources, and Economic Growth.* JHP, 1960. 742 pp. Cloth out of print. Paper edition (University of Nebraska Press) 1965. $2.40.

Perloff, Harvey S., with Vera W. Dodds. *How a Region Grows: Area Development in the U.S. Economy.* For general readers, based on *Regions, Resources, and Economic Growth.* Committee for Economic Development, New York (Supplementary Paper No. 17), 1963. 148 pp. Paper, $2.25.

Perloff, Harvey S., and Richard P. Nathan, eds. *Revenue Sharing and the City* (see Heller et al.).

Perloff, Harvey S., and Lowdon Wingo, Jr., eds. *Issues in Urban Economics.* JHP, 1968. 678 pp. $15.00. Paper, $5.00.

Resources for the Future. *Design for a Worldwide Study of Regional Development.* A report to the United Nations on a proposed research-training program. RFF, 1966; second printing 1967. 92 pp. Paper, $1.50.

Rogers, George W. *Alaska in Transition: The Southeast Region.* JHP, 1960; second printing 1967. 398 pp. $10.00.

Rogers, George W. *The Future of Alaska: Economic Consequences of Statehood.* JHP, 1962. 324 pp. $8.50.

Schaller, Howard G., ed. *Public Expenditure Decisions in the Urban Community*—papers presented at a 1962 conference sponsored by the Committee on Urban Economics. RFF, 1963; third printing 1968. 208 pp. Paper, $3.50.

Thompson, Wilbur R. *A Preface to Urban Economics.* JHP, 1965; second printing 1967. 428 pp. $7.50. Paper 1969, $2.95. Japanese edition. *Toshi Kuzai Goku Josetsu.* Tokyo: Kajima Institute Publishing Co., Ltd., 1969. 390 pp. 1700 Y.

Wingo, Lowdon, Jr., ed. *Cities and Space: The Future Use of Urban Land*—essays based on the RFF Forum lectures of 1962. JHP, 1963; third printing 1967. 268 pp. $8.00. Paper 1969, $2.45. Japanese edition. Tokyo: Kajima Institute Publishing Co., Ltd., 1969. 270 pp. 1300 Y.

Wingo, Lowdon, Jr. *Transportation and Urban Land.* RFF, 1961; third printing 1968. 144 pp. Paper $2.50.

LATIN AMERICAN STUDIES

*Crosson, Pierre R. *Agricultural Development and Productivity: Lessons from the Chilean Experience.* JHP, November 1970. 208 pp. $7.00.

*Grunwald, Joseph, and Philip Musgrove. *Natural Resources in Latin American Development.* JHP, 1970. 512 pp., 8½"x11", 248 tables. $20.00.

Herfindahl, Orris C. *Natural Resource Information for Economic Development.* JHP, 1969. 232 pp. $7.00.

*Mikesell, Raymond F., and associates (see under Energy and Nonfuel Minerals).

*Perloff, Harvey. *Alliance for Progress: A Social Invention in the Making.* JHP, 1969. 288 pp. $8.50.

Wollman, Nathaniel. *The Water Resources of Chile: An Economic Method for Analyzing a Key Resource in a Nation's Development.* JHP, 1968. 296 pp. $7.50.

STUDIES UNDERTAKEN WITH RFF SUPPORT AND PUBLISHED BY OTHER INSTITUTIONS DURING THE LAST FIVE YEARS

Berry, Brian J. L., and Andrzej Wróbel, eds. *Economic Regionalization and Numerical Methods.* Report of the Commission on Methods of Economic Regionalization of the International Georgraphical Union. Warsaw: Polish Academy of Sciences, Institute of Geography, 1968. 240 pp., paper, Zl. 56 (approx. $2.50). (Research supported by grants to University of Chicago.)

Bradley, Paul G. *Economics of Crude Petroleum Production.* Voorburgwal, Amsterdam: North-Holland Publishing Co., 1967. 149 pp., fl. 32.50 (approx. $10.00). (Grant to Massachusetts Institute of Technology.)

Brock, Samuel M., and David B. Brooks. *The Myles Job Mine: A Study of Benefits and Costs of Surface Mining for Coal in Northern West Virginia.* Series 68, no. 10-5. Morgantown: West Virginia University Center for Appalachian Studies and Development, 1968. 61 pp. (Grant to West Virginia University Foundation.)

Duncan, Beverly, and Stanley Lieberson. *Metropolis and Region in Transition.* Beverly Hills: Sage Publications, 1970. 316 pp. $8.95. (Grant to University of Michigan.)

Fiering, Myron B. *Streamflow Synthesis.* Cambridge: Harvard University Press, 1966. 160 pp., $6.00. (Grant to Harvard University.)

Fishman, Leo, ed. *Poverty Amid Affluence.* New Haven: Yale University Press, 1966. 258 pp.; cloth, $6.00; paper, $1.75. (Grant to West Virginia University Foundation.)

Frank, Helmut J. *Crude Oil Prices in the Middle East: A Study in Oligopolistic Price Behavior.* Praeger Special Studies in International Economics and Development. New York: Frederick A. Praeger, Inc., 1966. 224 pp., $15.00. (Grant to University of Arizona.)

Gerwin, Donald. *Budgeting Public Funds: The Decision Process in an Urban School District.* Madison: University of Wisconsin Press, 1969. 170 pp., $7.50. (Grant to Carnegie-Mellon University.)

Guyol, N. B. *The World Electric Power Industry.* Berkeley: University of California Press, 1969. 386 pp., $20.00 (Grant to University of California, Berkeley.)

Hart, William J. *A Systems Approach to Park Planning.* Report of a Study for the Committee on Park Systems Planning of the IUCN International Commission on National Parks. IUCN Publications, New Series, Supplementary Paper no. 4. Washington, D.C.: IUCN, 1966. 134 pp., $1.50. (Grant to International Union for Conservation of Nature and Natural Resources.)

Hirsch, Werner Z., and Sidney Sonenblum. *Selecting Regional Information for Government Planning and Decision-Making.* New York: Praeger Publishers, 1970. 212 pp. $12.50. (Grant to University of California, Los Angeles.)

Hufschmidt, Maynard M., and Myron B. Fiering. *Simulation Techniques for Design of Water-Resource Systems.* Cambridge: Harvard University Press, 1966. 230 pp., $7.50. (Grant to Harvard University.)

League of Women Voters of the United States, Education Fund. *The Big Water Fight: Trials and Triumphs in Citizen Action on Problems of Supply, Pollution, Floods, and Planning across the U.S.A.* Brattleboro, Vt.: The Stephen Greene Press, 1966. 256 pp., $6.95. (Grant to League of Women Voters.)

Löf, George O. G., J. A. Duffy, and Clayton O. Smith. *World Distribution of Solar Radiation.* Solar Engineering Laboratory, Engineering Experiment Station Report No. 21. Madison: University of Wisconsin. 1966. 50 pp. and 13 maps. (Grants to University of Wisconsin.)

McCullough, Dale R. *The Tule Elk: Its History, Behavior, and Ecology.* Publications in Zoology, vol. 88. Berkeley and Los Angeles: University of California Press, 1969. 209 pp. $6.50. (Grant to University of California.)

MacAvoy, Paul W. *Economic Strategy for De-*

veloping Nuclear Breeder Reactors. Cambridge and London: M.I.T. Press, 1969. 216 pp., $10.00. (Grant to Massachusetts Institute of Technology.)

Mead, Walter J. *Competition and Oligopsony in the Douglas Fir Lumber Industry.* Berkeley: University of California Press, 1966. 290 pp., $6.00. (Grant to University of California, Santa Barbara.)

Mennes, L. B. M., Jan Tinbergen, and J. George Waardenburg. *The Element of Space in Development Planning.* Voorburgwal, Amsterdam: The North-Holland Publishing Co., 1969. 340 pp. (Grant to Netherlands Economic Institute.)

Muehlbeier, John, Otto Thiemann, Howard W. Ottoson, and Loyd K. Fischer. *The Development of a Program for the Salt Wahoo Watershed in Nebraska.* Lincoln: University of Nebraska College of Agricultural and Home Economics. The Agricultural Experiment Station, SB 490, 1966. 56 pp. (Grant to University of Nebraska.)

Muench, John, Jr. *Private Forests and Public Programs in North Carolina.* Washington, D.C.: The American Forestry Association, 1966. 104 pp., $1.00. (Grant to Duke University.)

Nash, Roderick W. *Wilderness and the American Mind.* New Haven: Yale University Press, 1967. 256 pp., $6.50. (Grant to University of Wisconsin.)

Ottoson, Howard W., Eleanor M. Birch, Philip A. Henderson, and A. H. Anderson. *Land and People in the Northern Plains Transition Area.* Lincoln: University of Nebraska Press, 1966. 376 pp., $7.95. (Grant to University of Nebraska.)

Saarinen, Thomas Frederick. *Perception of the Drought Hazard on the Great Plains.* Department of Geography Research Paper no. 106. Chicago: University of Chicago, 1966. 196 pp., $4.00. (Grant to University of Chicago.)

Schlebecker, John. *Living Historical Farms: A Walk into the Past.* Smithsonian Institution Publication 4747. Washington, D.C.: Smithsonian Institution, 1968. Distributed by Port City Press, Baltimore. 31 pp., free. (Grant to Smithsonian Institution.)

Smith, Wallace F. *Housing: The Social and Economic Elements.* Berkeley and Los Angeles: University of California Press, 1970. 528 pp., $12.95. (Grant to University of California, Berkeley.)

Thomas, Ray. *Aycliffe to Cumbernauld: A Study of Seven New Towns in Their Regions.* vol. 35, broadsheet 516. London: Political and Economic Planning, December 1969. 172 pp. 20s. (Grant to Political and Economic Planning.)

Thomas, Ray. *Journeys to Work.* vol. 34, broadsheet 504. London: Political and Economic Planning, November 1968. 84 pp. 7s. 6d. (Grant to Political and Economic Planning.)

Thomas, Ray. *London's New Towns: A Study of Self-contained and Balanced Communities.* vol. 35, broadsheet 510. London: Political and Economic Planning, April 1969. 100 pp. 10s. (Grant to Political and Economic Planning.)

Wonnacott, Ronald J., and Paul Wonnacott. *Free Trade between the United States and Canada: The Potential Economic Effects.* Cambridge: Harvard University Press, 1967. 452 pp., $9.00. (Grant to University of Western Ontario.)

RFF REPRINT SERIES STILL AVAILABLE*

36. *Mineral Import and Stabilization Policies,* by Orris C. Herfindahl. Presented at the American Institute of Mining and Metallurgical Engineers Meeting, Society of Mining Engineers Minerals Economics Program, New York, February 19, 1962.
66. *The Lead-Zinc Anomaly,* by David B. Brooks. Reprinted from *Transactions* (Society of Mining Engineers), June 1967.
67. *Conservation Reconsidered,* by John V. Krutilla. Reprinted from *American Economic Review,* September 1967.
71. *Economics and the Quality of the Environment — Some Empirical Experiences,* by Allen V. Kneese. Reprinted from *Social Sciences and the Environment,* University of Colorado Press, 1967.
74. *Nuclear Power in East Europe,* by Jaroslav G. Polach. Reprinted from *East Europe,* May 1968.
75. *Latin American Urbanization: Plan or Process?* by Lowdon Wingo. Reprinted from *Shaping an Urban Future,* by Bernard J. Frieden and William Nash, The M.I.T. Press, 1969.
76. *Production, Consumption, and Externalities,* by Robert U. Ayres and Allen V. Kneese. Reprinted from *American Economic Re-*

---

* Reprints listed are available from RFF; single copies free on request; additional copies of the same reprint at 25 cents each, except No. 85 (50 cents).

view, June 1969.

77. *The Definition and Measurement of Drought Losses: The Northeast Drought of 1962-66*, by Clifford S. Russell. Reprinted from *Proceedings of the Fourth American Water Resources Conference*, 1969.
78. *Desalted Sea Water for Agriculture: Is It Economic?* by Marion Clawson, Hans H. Landsberg, and Lyle T. Alexander. Reprinted from *Science*, June 6, 1969.
79. *The Energy Gap in the Communist World*, by Jaroslav G. Polach. Reprinted from *East Europe*, June 1969.
80. *Pervasive External Costs and the Response of Society*, by Allen V. Kneese and Ralph C. d'Arge. Reprinted from *The Analysis and Evaluation of Public Expenditures: The PPB System*, A compendium of papers submitted to the Subcommittee on Economy in Government of the Joint Economic Committee, 91 Cong. 1 sess. (1969).
81. *Negotiation and Land Conversion*, by George M. McBride and Marion Clawson. Reprinted from *Journal of the American Institute of Planners*, January 1970.
82. *A New Policy Direction for American Agriculture*, by Marion Clawson. Reprinted from *Journal of Soil and Water Conservation*, January-February 1970 (vol. 25, no. 1).
83. *Relative Importance of Variables in Water Resources Planning*, by I. C. James II, B. T. Bower, and N.C. Matalas. Reprinted from *Water Resources Research*, December 1969 (vol. 5, no. 6).
84. *Coalitions, Minority Representation, and Vote-Trading Probabilities*, by Edwin T. Haefele. Reprinted from *Public Choice*, Spring 1970.
85. *The Development of Energy in East Europe*, by J. G. Polach. Reprinted from *Economic Developments in Countries of Eastern Europe*, A compendium of papers submitted to the Subcommittee on Foreign Economic Policy of the Joint Economic Committee, 91 Cong. 2 sess. (1970).
86. *International Flows of Energy Sources*, by Joel Darmstadter. Reprinted from *IEEE Spectrum*, May 1970.
87. *Marigenous Minerals: Wealth, Regimes, and Factors of Decision*, by Francis T. Christy, Jr. Reprinted from *Symposium on the International Regime of the Sea-Bed: Proceedings* (Rome: Accademia Nazionale dei Lincei, 1970).
88. *Protecting our Environment and Natural Resources in the 1970's*, by Allen V. Kneese. Reprinted from *The Environmental Decade (Action Proposals for the 1970's)*, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 91 Cong. 2 sess. (Washington: U.S. Government Printing Office, 1970).
89. *Middle Eastern Oil in the Next Decade: Some Prospects and Problems*, by Sam H. Schurr. Reprinted from *Proceedings of the Council of Economics*, American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Annual Meeting, Denver, Colorado, February 15-19, 1970.

Related Staff Activities and Writings

ACTIVITIES — A SELECTIVE LIST

BLAIR T. BOWER. On editorial boards of the *Journal of Soil and Water Conservation* and the *Natural Resources Journal;* member of the Maryland Water Sciences Advisory Board, of National Sanitation Foundation Advisory Committee on the use of disposable bags in New York City, and alternate member for Arlington County of the Potomac-Shenandoah Basin Advisory Committee. Faculty member in urban problems and planning, Salzburg Seminar in American Studies, Austria; and of the World Health Organization Training Course on Coastal Pollution, Aarhus, Denmark. Visiting lecturer, Department of City and Regional Planning, University of North Carolina. Consultant to the Canadian Department of Energy, Mines and Resources on air quality management and on environmental quality management; to International Systems Development, Inc. on an Ivory Coast water project; to the Center for Environment and Man in Hartford on thermal pollution; and to the Miami Conservancy District and the Maryland Department of Water Resources on water quality management. Chaired session and presented paper, "Economics of Water Quality Management," at the International Scientific Symposium on Computers and Water Resources Management at the Université de Montpellier, France. Lectured on residuals management to the Vermont Commission on Non-Returnable Containers, and on environmental quality management at two seminars at the University of California, Berkeley; to the Arlington Committee of 100; to the Panel on the Environment, President's Science Advisory Committee; and to the Institut d'Urbanisme, Université de Paris.

MICHAEL F. BREWER. Consultant to the Program of Environmental Studies, Oak Ridge National Laboratory, regarding the laboratory involvement in problems of environment and technological assessment; to the Review Committee, University of Michigan, regarding the relationship of the School of Natural Resources to other university programs; to the Task Force of the Chancellor's Committee on Environmental Studies, University of Connecticut, regarding environmental studies in the College of Letters and Sciences; and to the Workshop on Computer Simulation of Resource Management, College of Fisheries, University of Washington. Chaired the Conference on Conservation and Environmental Problems at Millbrook School, Millbrook, N.Y. Presented two papers: "Managing Water for Environmental Enhancement," at the American Association for the Advancement of Science Symposium in Boston; and "Environment, Pollution, and the Quality of Life," at the National Agricultural Policy Conference in Pokagon State Park, Indiana. Lectured on the economic relationship between population and environment as participant in the Population Problems Lecture Series at the University of Delaware; on priorities and commitments for environmental education at the Workshop on Environmental Education for Everyone, held in Cincinnati and sponsored by the National Science Teachers Association; and on urban decision making at the Western Resources Conference on Urban Demands on Natural Resources, University of Denver.

FRANCIS T. CHRISTY, JR. Consultant to the National Council on Marine Resources and

Engineering Development and also member of the executive committee of the Law of the Sea Institute. Participated in the Malta conference *Pacem in Maribus,* and in two of the conference planning sessions sponsored by the Center for the Study of Democratic Institutions; prepared background paper, "Fisheries, Common Property, Open Access, and the Common Heritage." Served on the Economics Advisory Panel, Division of Fisheries, Food and Agriculture Organization of the United Nations, Rome. Conducted seminars on the law of the sea and the economics of sea resources at the Conservation Foundation, at The Johns Hopkins University School for Advanced Studies in Washington, D.C., and at The Johns Hopkins University in Baltimore. Participated in planning program for the Fifth Annual Conference of the Law of the Sea Institute in Kingston, R.I., and chaired one of the sessions.

CHARLES CICCHETTI. Adviser to the Subcommittee on Outdoor Recreation, Northeast Regional Resources Research Committee. Testified during Federal Power Commission hearings on the proposed Hells Canyon dam. Presented paper, "Some Reasons for the Destruction of Our Environment," on Earth Day at the U.S. Air Force Academy in Colorado Springs, and participated in the land use panel discussion at the Earth Week Conference, Temple University.

MARION CLAWSON. Member, board of directors of the National Conference on State Parks; chairman, Flood Insurance Advisory Committee, Department of Housing and Urban Development; served on the Committee on Arid Lands, American Association for the Advancement of Science, and on the Committee on Constitutional Revision, Society for International Development. Prepared paper, "Management Planning of Forested Watersheds," read at the Joint FAO/U.S.S.R. International Symposium on Forest Influences and Watershed Management, in Moscow. Other papers included "The Meaning of an Urban Land Strategy," presented to Lambda Alpha (honorary land economics fraternity), Washington, D.C.; "Who Manages Land Resources?" to the American Public Health Association, Philadelphia; "Economic Limitations in Sea Water Conversion for Commercial Agriculture," to the American Society of Civil Engineers, Memphis; "Population, Settlement, and Growth Patterns," to the American Agricultural Economics Association, Columbia, Mo.; and "State Parks and Recreation Areas Are Vital," to the National Conference on State Parks, Myrtle Beach, S.C. Conducted seminar on rural poverty at Oberlin College, and one on the suburban land market at the University of Washington. Participated in the 34th Industrial Forestry Seminar at Yale University, and in seminars on flood insurance at Virginia Polytechnic Institute; on U.S. suburban growth at Open University in Milton Keynes, England; and on the impact of the rural-urban population movement at the Northeast Regional Resource Economics Council, Boston. Lectured on social needs and the urban-marine environment, University of California (four campuses); on management of the rural complex, Texas A&M University; and on effects of urban expansion on the rural countryside, Lambda Alpha, Washington, D.C.

PIERRE R. CROSSON. Conducted seminar on agricultural development planning at the Economic Development Institute of the International Bank for Reconstruction and Development.

JEROME K. DELSON. Testified at a Federal Power Commission hearing on proposals to collect data on control of pollution from steam-electric generating plants. Appeared as consultant before the President's Task Force on Air Pollution.

EDGAR S. DUNN, JR. President, the Southern Economic Association. Member of the Advisory Board for the Project on Computer Data Banks, National Academy of Sciences; Program Planning Committee on Primary Prevention, National Institute of Mental Health; and Committee on American Population Distribution, National Planning Association. Presented paper, "Regional Information Systems in the United States," at the Conference on Information Systems for Regional Development sponsored by the U.N. Research Institute for Social Development and held in Lund, Sweden. Participated in discussion of the Information Utility and Public Choice Panel at the 1970 Spring Joint Computer Conference of the American Federation of Information Processing Societies in Atlantic City.

JOSEPH L. FISHER. Gave two keynote addresses: "Science, Technology, and Human Needs," at the Western Governors' Conference in Denver; and "A Larger Future for Soil Conservation," at the 25th Annual Meeting of the Soil Conservation Society at York University, Toronto. Delivered the Otto H. Liebers Lecture in Natural Resources Development at the University of Nebraska in connection with the tenth anniversary of the Salt Valley Watershed District. Moderated the plenary session of the First National Congress on Optimum Population and Environment held in Chicago, and was a discussant in a session on optimum population at the American Association for the Advancement of Science meeting in Boston. At the Conference on the Future of Alaska, held in Anchorage, spoke on the financial foundation for the state's future. Member, Committee on Public Engineering Policy of the National Academy of Engineering. Participated in the meeting of the Meyer Report Review Group called by the president of Yale University to help make decisions about future environmental studies and the role of urban and environmental planning at Yale. Spoke on environmental quality problems at the Western Electric Company in Oklahoma City; the Fourth Annual Conference of Regional Councils in Atlanta; and, during Earth Week, at the University of Pennsylvania. Other speaking engagements included talks on the social architecture of metropolis before the Northern Virginia Section of the American Institute of Architects in Arlington; on the prospects for regional councils at the First Annual Symposium on Managing an Urban World held at the Center for Urban Studies, Wayne State University; on U.S. resources at the Department of State Senior Seminar in Foreign Policy; and on the economic consequences of natural resource development in urban economics at the National Conference on Urban Water Resources Research sponsored by the Department of the Interior and held in Atlanta.

MASON GAFFNEY. Conducted a seminar on economics and air pollution control at Oregon State College; discussed environmental quality and full employment at a seminar of the John Muir Institute in Aspen; and addressed the Economics Seminar at Colorado State University. Presented three papers: "Capital Turnover: A Way Out of the Inflation-Unemployment Hangup," before the Western Economics Association in Davis, California; "Taxation and Full Employment: the Case of Timber," before the Committee on Taxation, Resources and Economic Development in Milwaukee; and "Replacement of Individual by Mass Systems in Urban Growth," before the American Real Estate and Urban Economics Association in New York. Lectured on mass systems in urban growth at North Carolina State College, on the economics of timing urban land-use succession at the University of Washington, and on preferential assessment of farm land in the urban fringe at the Dane County Regional Planning Association in Madison, Wis.

EDWIN T. HAEFELE. Served on the Task Force on Research and Experience Abroad and on the Steering Committee for the Urban Goods Movement Conference of the Highway Research Board of the National Academy of Sciences. Presented testimony during hearings on coastal zone management held by the Subcommittee on Oceanography of the House Committee on Merchant Marine and Fisheries. Presented a paper, "Transport in the North: A Case for International Cooperation," at the 10th Annual Transportation Research Forum in Washington, D.C., and another, "Political Impediments to the Adoption of Advanced Urban Transport Systems," at the "Carnegie-Mellon Conference on Advanced Urban Transport Systems," in Pittsburgh. Lectured on environmental quality and social choice at the Brookings Institution Conference of New England State Officials in Durham, N.H.

ROBERT H. HAVEMAN. Member, Research Advisory Panel for Economics of the National Science Foundation. Conducted seminars on public policy, federal expenditures, and Congress at the Educational Program in Systems Analysis, University of Maryland, and at the National Science Foundation Junior College Institute in Economics, Purdue University. Conducted seminar on ex-post evaluation of federal resources investments at the U.S. Bureau of the Budget. Participated in the Brookings Institution Conference on Public Policy for Student Loans, and in the Conference on Federal Financing of Higher Education sponsored by the American College Testing Service in Washington, D.C. Spoke on the economic evaluation of water resources investments at the American Water Resources Association Research

Conference in Milwaukee, and on the federal water pollution control policy at the Women's National Democratic Club.

ORRIS C. HERFINDAHL. In Paracas, Peru, in collaboration with the Oficina Nacional de Evaluación de Recursos Naturales, conducted seminar on the development and use of information about Latin American natural resources. Consulted with ONERN officials about Peruvian resource problems and with members of the Instituto de Investigación de Recursos Naturales, following up the latter consultation with a report, "Some Comments on the Regional Studies of IREN." Presented a paper, "Problems of Governments in the Provision of Information for Material Supply," at the Second Inter-American Conference on Materials Technology in Mexico City. At the University of Virginia, presented an Earth Week lecture on meeting increasing demands on resources. Participated in seminars sponsored by the Organization of American States and by the water resources program of the U.S. Geological Survey, and spoke on mineral policy problems to the House Republican Task Force on Earth Resources and Population.

IRVING HOCH. Received a Fulbright-Hays award for a senior lectureship at the New Autonomous University of Madrid, where he advised the faculty of the School of Economics and Business on setting up programs in regional, urban, and agricultural economics. Served as consultant to the Engineering and Urban Health Sciences Study Section, Consumer Protection and Environmental Health Service, U.S. Public Health Service. Lectured on the state of urban economics at the Washington Center for Metropolitan Studies. Served as RFF host at Conference on Health Economics, sponsored by Committee on Regional Accounts, in Washington, D.C.

CHARLES W. HOWE. Social science editor of *Water Resources Research*, and member of the Committee on Technology and Water and of the Committee on Atmospheric Sciences, both of the National Academy of Sciences.

ALLEN V. KNEESE. Co-chaired the International Symposium on Environmental Disruption in Tokyo. As member of the Committee Advisory to the Environmental Science Services Administration (National Academy of Sciences–National Academy of Engineering), presented statement on a model of regional environmental science services at the ESSA Steering Group meeting in Madison, Wis.; appeared as consultant before the President's Task Force on Air Pollution, and participated in a seminar of the President's Advisory Council on Executive Organizations. As faculty member of the Summer Institute for College Teachers of Urban Economics sponsored by the National Science Foundation at Stanford University, taught section on environmental economics. Taught course on economic research and policy with respect to U.S. environmental pollution at the Scandinavian Summer School in Economics in Køge, Denmark. Testified on protecting the environment in the 1970s before the Subcommittee on Conservation and Natural Resources of the House Committee on Government Operations. Conducted seminars on strategies for environmental improvement at Skidmore College, on a general equilibrium approach to externalities at Princeton University, and on environmental economics and policy before the Committee on Research in Public Administration of the National Capital Area Chapter of the American Society for Public Administration. Directed panel on analyzing problems of future emissions from energy conversion and transportation at the MIT Summer Study on Critical Environmental Problems, Williams College. With Robert Haveman, presented paper on "The Economics of Common Property Resources," at the Brookings Institution. Presented a paper, "Policy on Environmental Quality," at a seminar of the Committee on Urban Public Economics, held at RFF. Participated in session, "Strategies for Avoiding Environmental Disaster," at the Colorado College Symposium in Colorado Springs. Spoke on how taxes could reduce effluent problems at the John Muir Institute for Environmental Studies "Forum for A Future" in Aspen, Colo. Served as consultant on environmental problems for CBS evening news.

JOHN V. KRUTILLA. Served as senior technical adviser for the U.N. Development Program–Poland Vistula River project; as member of the Mekong Seminar of the Southeast Asia Development Advisory Group (U.S. Agency for International Development); and as consultant to the Federal Power Commission. During summer was resident scholar at Lubrecht Forest and visiting social scientist at the U.S. Forest

Service Forest Sciences Laboratory at the University of Montana. Participated in the American Institute of Biological Sciences interdisciplinary workshop at the University of Wyoming and gave paper on alternatives in resource development. Served on the Committee on Support of Dissertation Research in Recreation and Leisure of the National Academy of Sciences and became a member of the National Air Quality Criteria Advisory Committee of the Environmental Health Service.

HANS H. LANDSBERG. As member of the U.S. group, participated in the Second World Food Congress at The Hague. Testified on the Resource Recovery Act of 1969 before the Subcommittee on Air and Water Pollution of the Senate Committee on Public Works. Served on three National Academy of Sciences committees: International Nutrition Programs, International Environmental Programs, and Consequences of Rapid Population Growth. Member of the Technical Advisory Committee on Load Forecasting Methodology, National Power Survey, Federal Power Commission. Presented papers: "Population, GNP, and the Environment," at the Conference on Technological Change and Population Growth at the California Institute of Technology; and "The Demonology of Pollution," at the Pittsburgh Earth Day Symposium sponsored jointly by the University of Pittsburgh, Carnegie-Mellon University, and Duquesne University. Spoke on energy at a meeting of the American Association for the Advancement of Science, Boston. Addressed the President's Commission on Population Growth and the American Future and the National Democratic Women's Club on population, resources, and the environment.

GEORGE O. G. LÖF. Served as consultant to World Health Organization on saline pollution abatement in the Oder river, southern Poland; and to the Center for Environment and Man on cost of thermal pollution abatement in electric power generation. At 1970 International Solar Energy Society Conference, Melbourne, Australia, chaired working party on solar distillation, presented paper on solar energy developments in United States, and compared theoretical and experimental analyses of solar distillation in Australia and United States. Member of National Academy of Sciences Committee on Technologies and Water, and of board of directors, Solar Energy Society.

NEAL POTTER. Consultant to the National Planning Association in updating survey of natural resource problems, goals, and costs. Lectured on the economic potential in Antarctica at the 1970 orientation session for Antarctic personnel of the U.S. Antarctic Research Program.

CLIFFORD S. RUSSELL. Consultant to group of geographers studying the urban snow hazard under grant from the Office of Water Resources Research; to the Rhode Island Natural Resources Group, a committee of citizens concerned with environmental planning. Participated in planning the program and chaired a session of the Conference on Coastal Zone Management, sponsored by Clemson University and the Agricultural Policy Institute of North Carolina State University and held in Charleston, S.C. In collaboration with Walter O. Spofford, Jr., conducted seminars on environmental problems at Harvard University, Johns Hopkins University, Oak Ridge National Laboratory, and at the meeting of the Committee Advisory to the Environmental Science Services Administration (National Academy of Sciences–National Academy of Engineering) in Miami. Participated in panel discussions related to Earth Day at George Washington University and Cornell University. Presented paper, "The Essential Trade-offs: Economic Health and Environmental Quality—Dynamics and Stability," at the 1970 Engineering Research Foundation Conference in Henniker, N.H.

SAM H. SCHURR. Consultant to the Research Department of the International Monetary Fund, regarding research on the international petroleum industry. As 1970 Henry Krumb Lecturer of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), spoke on problems of the world petroleum industry before sectional meetings in New York, San Francisco, Charlottesville, Va., and Carlsbad, N.M. Lectured on prospects and problems of oil in the Middle East at the AIME annual meeting in Denver; on the evolution of U. S. petroleum policies at the Rocky Mountain Petroleum Economics Institute in Jackson Hole; and on shifts in energy resources at the Research Resources

Conference sponsored by the Georgetown University Center for Strategic and International Studies.

WALTER O. SPOFFORD, JR. Consultant in the MIT Summer Study on Critical Environmental Problems held at Williams College; panelist in an Earth Day discussion at Northern Virginia Community College. In collaboration with Clifford Russell, conducted seminars on environmental problems at Harvard University, The Johns Hopkins University, Oak Ridge National Laboratory, and at a meeting of the Committee Advisory to the Environmental Science Services Administration (National Academy of Sciences–National Academy of Engineering) in Miami. Presented paper, "Solid Waste Management: Some Economic Considerations," at the annual meeting of the American Chemical Society, Division of Water, Air, and Waste Chemistry, in Chicago.

LOWDON WINGO. Consultant on regional and urban development to the International Bank for Reconstruction and Development. At Arden House, New York, participated in meeting of the American Assembly, which considered "The States and the Urban Problem." Member of the Land Use Evaluation Committee, Highway Research Board, National Academy of Sciences; and of the Executive Committee, Interuniversity Committee on Urban Economics.

ROBERT A. YOUNG. Presented paper, "The Safe Yield of Aquifers: An Economic Reformulation," before the Irrigation and Drainage Division of the American Society of Civil Engineers, Austin, Texas.

WRITINGS — A SELECTIVE LIST

Bower, Blair T., with I. C. James II and N. C. Matalas. "Relative Importance of Variables in Water Resources Planning." *Water Resources Research*, December 1969.

Brewer, Michael F. "Environmental Issues for State and Local Governments." *Congressional Record*, December 29, 1969. Originally presented as a paper at the Southern Conference of the Council of State Governments, Mobile, Alabama, July 1969.

———. "Full Disclosure in Environmental Use." *Journal of Environmental Education*, vol. 1, no. 4, 1970.

Christy, Francis T., Jr. "Marigenous Minerals: Wealth, Regimes, and Factors of Decision." In *Symposium on the International Regime of the Sea-Bed: Proceedings*, edited by Jerzy Sztucki. Rome: Accademia Nazionale dei Lincei, 1970.

———. "Fisheries and the New Conventions on the Law of the Sea." *San Diego Law Review*, July 1970.

———. "New Dimensions for Transnational Marine Resources." *American Economic Review*, May 1970.

Cicchetti, Charles J., with V. Kerry Smith. "A Note on Jointly Supplied Mixed Goods." *Quarterly Review of Economics and Business*, vol. 10, no. 3, 1970.

———, with Joseph J. Seneca. "A Gravity Model Analysis of the Demand for Public Communication." *Journal of Leisure Research*, vol. 1, no. 3, 1969.

———. "User Response in Outdoor Recreation: A Production Analysis." *Journal of Regional Science*, vol. 9, no. 3, 1969.

Darmstadter, Joel. "Energy and the Economy." *Energy International*, August 1970.

———. "The Interindustry Setting of Electric and Gas Utilities." *Public Utilities Fortnightly*, July 16, 1970.

———. "International Flows of Energy Sources." *IEEE Spectrum*, May 1970.

Dunn, Edgar S., Jr. "Economics and a New Social Science Threshold." *Southern Economic Journal*, April 1970.

———. "The Idea of the National Data Center and the Issue of Privacy." In *Information Systems in a Democracy*, edited by Alan F. Westin. Cambridge: Harvard University Press, 1970.

———. "The Information Utility and the Idea of the Public Data Bank." In *The Information Utility and Social Choice*, edited by Harold Sackman and Norman Nie, Montvale, N.J.: AFIPS Press, 1970.

———. "Regional Information Systems in the United States." In *Proceedings of the Conference on Information Systems for Regional Development*, sponsored by the United Nations Research Institute and the University of Lund. Lund, Sweden: University of Lund Press, 1970.

———. "Voice of the User." An editorial in *Computer Decisions*, April 1970.

Fisher, Joseph L. "Alaska Oil in Historical Perspective." In *Proceedings of the Twentieth Alaska Science Conference,* sponsored by the Alaska Division of the American Association for the Advancement of Science. New York: Multiprint, 1970.

———. "Consequences of Population Growth on America's Environment." In *Hearings before the Subcommittee on Conservation and Natural Resources of the Committee on Government Operations,* 91 Cong., 1 sess., September 15, 1969.

———. "Economic and Social Aspects of Environmental Enhancement." In *Man and His Urban Environment,* edited by Ernest Foulkes and Edward Cleary. Cincinnati: University of Cincinnati, 1970.

———. "Reflections on the Conference Theme—Conservation in an Urbanizing Society: An Appraisal of the Program of the 34th North American Wildlife and Natural Resources Conference." In *Transactions of the 34th North American Wildlife and Natural Resources Conference, March 2-5, 1969.* Washington, D.C.: Wildlife Management Institute, 1970.

———. "The Several Contexts of Water." In *America's Changing Environment,* edited by Roger Revelle and Hans H. Landsberg. Boston: Houghton Mifflin, 1970.

Gaffney, Mason. "Adequacy of Land as a Tax Base." In *The Assessment of Land Value,* edited by Daniel Holland. Madison: University of Wisconsin Press, 1970.

———. "Land Assessments in Milwaukee." *Nation's Cities,* October 1970.

———. "Land Rent, Taxation, and Public Policy." In *Proceedings of the Fifteenth Annual U.S. Meeting of the Regional Science Association,* edited by Morgan D. Thomas. Philadelphia: Department of Regional Science, Wharton School, University of Pennsylvania, 1970.

———."Tax-induced Slow Turnover of Capital." *American Journal of Economics and Sociology,* January, April, July, and October 1970.

Haefele, Edwin T. "Coalitions, Minority Representation, and Vote-Trading Possibilities." *Public Choice* VIII, Spring 1970.

———. "Transport in the North: A Case for International Cooperation." In *Proceedings of the Tenth Annual Transportation Forum, Washington, D.C., October 1969.* Oxford, Ind.: Richard B. Cross, 1969.

Haveman, Robert H. "The Public Financing of Higher Education: An Economist's View," *Liberal Education,* May 1970.

Herfindahl, Orris C. "Problems of Governments in the Provision of Information for Materials Supply." In *An Interamerican Approach for the Seventies: Materials Technology—I.* New York: United Engineering Center of the American Society of Mechanical Engineers for the Southwest Research Institute, 1970.

Hoch, Irving. "Cobb-Douglas Production Functions for California Dairy Farms, with Some Supply Applications." In *Demand and Supply Analysis Tools in Dairy Price and Income Policy.* Columbus: Department of Agricultural Economics, Ohio State University, 1970.

———, with N. Tryphonopoulos. *A Study of the Economy of Napa County, California.* Research Report No. 303. Berkeley: Giannini Foundation of Agricultural Economics, University of California, 1969.

Kneese, Allen V. "Direction of Needed Research and International Cooperation in the Future." In *A Challenge to Social Scientists,* Proceedings of the International Symposium on Environmental Disruption, edited by Shigeto Tsuru. Tokyo: Asahi Evening News, 1970.

———. "Economic Responsibility for the By-Products of Production." *Annals of the American Academy of Political and Social Science,* vol. 389, May 1970.

———. "La Calidad del Agua y el Desarrollo Económico" [Water Quality in Economic Development]. *Boletín de la Oficina Sanitaria Panamericana,* vol. 69, no. 1, Julio 1970.

———. "Protecting Our Environment and Natural Resources in the 1970s." In *The Environmental Decade (Action Proposals for the 1970s).* Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 91 Cong. 2 sess. Also in *The Forensic Quarterly* of the Committee on Discussion and Debate of the National University Extension Association, part two, vol. 44, no. 2, May 1970.

———, with J. C. Headley. "Economic Implications of Pesticide Use." *Annals of the New York Academy of Sciences,* vol. 160, 1969.

Krutilla, John V. "Outdoor Recreation Economics." *Annals of the American Academy of Social and Political Science,"* May 1970.

Landsberg, Hans H., with Roger Revelle, coeditor of *America's Changing Environment.* Boston: Houghton-Mifflin, April 1970, and Beacon Press, September 1970 (paperback).

Löf, George O. G., with R. A. Tybout. "Solar House Heating." *Natural Resources Journal,* vol. 10, no. 2, 1970.

———, with J. A. Eibling and S. G. Talbert. *Manual on Solar Distillation of Saline Water,* Office of Saline Water Report, 1970.

———, with J. A. Ward. chap. 10 in *Engineering Aspects of Thermal Pollution,* edited by Parker and Krenkel. Vanderbilt University Press, 1969.

Russell, Clifford S. "Applications of Mathematical Economics in Marine Resources Research." In *Proceedings of the Fourth Annual*

Conference of the Law of the Sea Institute. Kingston, R.I.: University of Rhode Island Press, March 1970.

———. "Perception of Choice and Factors Affecting Industrial Water Supply Decisions: A Note on the Study by Shue Tuck Wong." *Geographical Review,* vol. 60, no. 1, 1970.

Schurr, Sam H. "Middle Eastern Oil in the Next Decade: Some Prospects and Problems." In *Proceedings of the Council of Economics, Annual Meeting, 1970.* New York: American Institute of Mining, Metallurgical, and Petroleum Engineers, 1970.

Young, Robert A., with John D. Bredehoeft. "Temporal Allocation of Ground Water: A Simulation Approach." *Water Resources Research,* February 1970.

FINANCIAL STATEMENTS

Price Waterhouse & Co.
1707 L Street, N.W.
Washington, D.C. 20036
October 30, 1970

To the Board of Directors of Resources for the Future, Inc.

In our opinion, the accompanying financial statements (Exhibits I, II and III) present fairly the assets, liabilities and fund balance of Resources for the Future, Inc., at September 30, 1970 and its income and expense for the year then ended in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year. Our examination of these statements was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

Price Waterhouse & Co.

Exhibit I

RESOURCES FOR THE FUTURE, INC.

STATEMENT OF ASSETS, LIABILITIES, AND FUND BALANCE, 30 SEPTEMBER 1970

ASSETS

Cash	$ 553,224
Certificates of deposit	400,000
Grants receivable from the Ford Foundation (Note 1)	6,684,788
Grant receivable from the Rockefeller Foundation (Note 2)	300,000
Other receivables	99,843
	8,037,855

LIABILITIES AND FUND BALANCE

Grants payable (Exhibit III)		$ 359,355
Accounts payable		36,389
Fund balance		
30 September 1969	$8,812,271	
Excess of expense over income for the year	1,170,160	7,642,111
		8,037,855

Exhibit II

RESOURCES FOR THE FUTURE, INC.

STATEMENT OF INCOME AND EXPENSE
FOR THE YEAR ENDED 30 SEPTEMBER 1970

INCOME			*Total*
Grant from the Ford Foundation			$ 150,000
Grant from the Rockefeller Foundation			500,000
Interest			49,905
Contracts with United States agencies and international agencies			122,780
			822,685
EXPENSE		*Grants*	
Program	*Staff*	*(Exhibit III)*	
Quality of the environment	$ 345,457	$ 99,296	444,753
Natural environments	90,313	13,362	103,675
Water	78,756	7,844	86,600
Land use and management	75,105	25,280	100,385
Energy and minerals	134,698	78,754	213,452
Regional and urban studies	102,000	89,210	191,210
Resource appraisals	39,289	(1,171)	38,118
Special projects	110,594	90,517	201,111
Latin American	171,820	(449)	171,371
Publications (less $101,551 received from sales of publications)	142,364		142,364
	1,290,396	402,643	1,693,039
Administrative			
Compensation and employee benefits			170,002
Travel			16,178
Rent			64,878
Furniture, supplies and equipment			12,954
Other administrative			35,794
			299,806
Total expense			1,992,845
EXCESS OF EXPENSE OVER INCOME			1,170,160

NOTES TO FINANCIAL STATEMENTS
FOR THE YEAR ENDED 30 SEPTEMBER 1970

Note 1. In October 1968 the Ford Foundation approved a grant of $8,000,000 for the general support of the activities of Resources for the Future for a five-year period beginning 1 October 1969. During the year Resources for the Future received $1,600,000 of this grant.

An additional grant of $295,000 was approved in January 1969 by the Ford Foundation for a special Latin American program. At 30 September 1970, $134,788 remained to be received under this grant.

In May 1970 the Ford Foundation approved a grant of $150,000 for support of the doctoral dissertation fellowship program for three years beginning 1 September 1970. No payments were received on this grant during the year ended 30 September 1970.

Note 2. In December 1969 the Rockefeller Foundation approved a grant of $500,000 for research on environmental quality for a two- to three-year period beginning 1 January 1970. Payments totalling $200,000 were received on this grant during the year ended 30 September 1970.

Exhibit III

RESOURCES FOR THE FUTURE, INC.

STATEMENT OF GRANTS
FOR THE YEAR ENDED 30 SEPTEMBER 1970

	Unpaid 30 Sept. 1969	*Changes during period*		*Unpaid 30 Sept. 1970*
		Grants (Reductions)	*Payments (Refunds)*	
QUALITY OF THE ENVIRONMENT PROGRAM				
California, University of				
Theoretical investigation of a general equilibrium model encompassing natural resources use	$ 9,945		$ 9,945	
Cornell University				
Management and control of community noise		$58,363		$58,363
Florida, University of				
Management decisions in the agricultural use of pesticides	10,000			10,000
Harvard University				
Research on urban environmental systems		9,700	9,700	
Social choices by local election		25,300		25,300
Indiana University				
Power structure and selected processes of environmental quality decisions		6,894	6,894	
Michigan, University of				
Economic considerations in the development of wetland-shoreline management strategies for San Francisco Bay		800		800
Temple University				
Economic evaluation of alternative air resource management policies	17,807		17,807	
Miscellaneous refunds		(1,761)	(1,761)	
	37,752	99,296	42,585	94,463

Exhibit III (continued)

	Unpaid	*Changes during period*		Unpaid
	30 Sept. 1969	*Grants (Reductions)*	*Payments (Refunds)*	*30 Sept. 1970*
NATURAL ENVIRONMENTS PROGRAM				
Bowling Green State University				
Differential incidence of technological change upon the demand and supply prices of natural resource commodities		$ 6,100		$ 6,100
Brown University				
Optimum use of natural areas		7,262	$ 7,262	
		13,362	7,262	6,100
WATER PROGRAM				
Purdue University				
Financing of public investment		8,000	8,000	
Southern Methodist University				
International aspects of weather modification	$43,625		31,375	12,250
Miscellaneous refunds		(156)	(156)	
	43,625	7,844	39,219	12,250
LAND USE AND MANAGEMENT PROGRAM				
Kansas State University				
Domestic agricultural policies in relation to world trade and development	14,500		14,500	
Montana State University				
Temporal allocation of natural resources in general, with applications to soil and livestock range conservation		19,665	12,995	6,670
Northwestern University				
The Forest Service bureaucracy under stress: an examination of community conflicts on the Carson National Forest		500	500	
Society of American Foresters				
Forestry curriculum development project	5,000		2,300	2,700
Syracuse University				
United States timber supply		6,000		6,000
Miscellaneous refunds		(885)	(885)	
	19,500	25,280	29,410	15,370
ENERGY AND MINERALS PROGRAM				
Massachusetts Institute of Technology				
Statistical models of mineral exploration		9,722		9,722
Melbourne, University of				
Finance and development of the Australian mining industry		9,550	9,550	

Exhibit III (continued)

	Unpaid	Changes during period		Unpaid
	30 Sept. 1969	Grants (Reductions)	Payments (Refunds)	30 Sept. 1970
ENERGY AND MINERALS PROGRAM (continued)				
North Carolina State University				
Revision of study of supply and costs in the U.S. petroleum industry	$16,535		$12,500	$ 4,035
Oregon, University of				
World copper production and markets		$20,708		20,708
Pennsylvania State University				
Coal demand in the 1970s	16,785		16,785	
Quantitative appraisal of mineral resources		41,229	20,615	20,614
Miscellaneous refunds		(2,455)	(2,455)	
	33,320	78,754	56,995	55,079
REGIONAL AND URBAN STUDIES PROGRAM				
Brown University				
Determinants of geographic patterns of population growth		31,385		31,385
California, University of				
Conference on Regional Accounts	17,600			17,600
Chicago, University of				
Research and education in urban economics	15,000		15,000	
Glasgow, University of				
An economic theory of the size of cities		9,820	9,820	
Johns Hopkins University				
Location of employment in urban areas	14,000		14,000	
New York University				
Workshop in urban economics	7,500			7,500
Interuniversity committee on urban economics	30,000	12,800	15,000	27,800
Pennsylvania, University of				
Seminar meetings of Committee on Urban Public Economics (transferred from Stanford University)		24,109		24,109
Seminar on models of land use development		2,342	2,342	
Pittsburgh, University of				
Training and research programs in urban economics	17,600		17,600	
Princeton University				
Location choices and optimum city size		33,317		33,317
Stanford University				
Seminar meetings of Committee on Urban Public Economics (transferred to University of Pennsylvania)	15,984	(24,109)	(8,125)	

Exhibit III (continued)

	Unpaid	Changes during period		Unpaid
	30 Sept. 1969	*Grants (Reductions)*	*Payments (Refunds)*	*30 Sept. 1970*
REGIONAL AND URBAN STUDIES PROGRAM (continued)				
Syracuse University Research and education in urban economics	$25,000		$10,000	$15,000
Wayne State University Research and education in urban economics	15,000		15,000	
Wisconsin, University of Comparative study of economic spatial systems	3,711	$ (454)	3,257	
	161,395	89,210	93,894	156,711
RESOURCE APPRAISALS PROGRAM				
Pennsylvania, University of *Resources in America's Future:* Regional and manpower dimensions of the appraisal	1,171	(1,171)		
SPECIAL PROJECTS PROGRAM				
American Geographical Society Assistance with publication of study of resource potentials of the Antarctic	1,000		1,000	
American Geophysical Union Monograph series on hydrology and water resource management		7,000	7,000	
Harvard University Advance reservation of land for public purposes	6,600		6,600	
Loyola University of Los Angeles Analysis of the law of the continental shelf and of the resources of the deep sea floor	5,000		5,000	
Rutgers—The State University Allocation and legal classification of the resources of the continental shelf and of the seabed	24,399		24,399	
Washington, University of Regulatory system for international fisheries		36,703	17,321	19,382
Doctoral Dissertation Fellowships		46,814	46,814	
	36,999	90,517	108,134	19,382
LATIN AMERICAN PROGRAM				
Miscellaneous refunds		(449)	(449)	
TOTAL GRANTS	$333,762	$402,643	$377,050	$359,355